

SPS LABORATORY REPORT

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REPORT NO. 5920

Torque vs. Induced Load of A-286,
and MP35N Nuts and Bolts with Cadmium,
Dry Film, and Cetyl Alcohol Lubricants

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SPS LABORATORIES, Jenkintown, Pennsylvania

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INTRODUCTION:

The torque-tension testing program recorded in this report is the result of a requirement by NASA to obtain data for specific joint design, utilizing various combinations of bolt, nut and lubricants in typical structure of the shuttle booster rocket. Data for the specific joint conditions were not available and could not be extrapolated from existing data.

Further requirements of the structure performance criteria were to withstand temperatures of 260°C (500°F) and to provide a nut lubricant which would be compatible with sealants used in the joint. Cadmium plating and dry film lubricant meeting the requirements of MIL-L-8937 were the lubricants specified by NASA. In a follow-up effort, cadmium plating and cetyl alcohol were further specified and tested.

The materials for the bolt and nut combinations were MP35N and A-286. These materials demand a lubricant to be used to prevent galling of the thread when tightened and also to help reduce the scatter of clamping load in application.

PURPOSE:

To determine the torque-tension relationship of:

1. EWB 0420 A286 bolts, 61170 cadmium plated nuts, 61170 cadmium plated nuts plus cetyl alcohol, and 61170 nuts with 620c dry film lubricant.
2. MD111-4020 MP35N bolts, EWNM26 cadmium plated nuts, and EWNM 26 nuts with 620c dry film lubricant.

RESULTS:

1. A286 bolts, and 61170 nuts.
 - 1.1 The torque vs. induced load curves for each size bolt and nut with lubricant tested are presented in Figures 4 through 18.
 - 1.2 The recommended torque to induce 90,000 psi joint clamping stress in the bolt threads was tabulated from each of the curves in 1.1. (Table VI)
2. MP35N Bolts, and EWNM 26 nuts
 - 2.1 The torque vs. induced load curves for each size bolt, and nut with lubricant tested are presented in Figures 19 through 28.
 - 2.2 The recommended torque to induce 90,000 PSI joint clamping stress in the bolt threads was tabulated from each of the curves in 2.1. (Table VII)

RECOMMENDATIONS:

Aircraft manufacturers have long recognized the variables associated with torque-tension relationship. Several of these companies are increasing their joint reliability by requiring fastener manufacturers to provide the torque to induce their specified bolt preload for each lot of nuts and bolts they purchase.

Because this is a good engineering approach to better joint reliability, the following recommendation is made:

For each new lot of A286, and MP35N bolts, and nuts purchased, the manufacturer should be required to provide ten (10) torque vs. induced load curves. These tests should be generated using the bolts, nuts, washers, and joint material as described in this report.

PROCEDURES:

1. Test Components

The following bolts, nuts, washers, and aluminum joint material were used to accomplish the objectives of this program.

1.1 High strength aircraft bolts

EWB-0420 A286MD111-4020 MP35N

EWB-0420-4-34
EWB-0420-5-38
EWB-0420-6-40
EWB-0420-6-22
EWB-0420-8-44
EWB-0420-8-46
EWB-0420-10-26
EWB-0420-10-50

MD111-4020-0417
MD111-4020-0547
MD111-4020-0634
MD111-4020-0822
MD111-4020-1025

1.2 High strength aircraft nuts

1.2.1 Cadmium plate per QQ-P-416 Type II, Class 3

A286MP35N

61170C-428
61170C-524
61170C-624
61170C-820
61170C-1018

EWNM26-428
EWNM26-524
EWNM26-624
EWNM26-820
EWNM26-1018

1.2.2 Cadmium plate per QQ-P-416 Type II, Class 3, plus
Cetyl alcohol (5 oz./gal.)A286

61170C-428
61170C-524
61170C-624
61170C-820
61170C-1018

1.2.3 620C dry film lubricant per MIL-L-8937

A286MP35N

61170M-428
61170M-524
61170M-624
61170M-820
61170M-1018

EWNM26-428
EWNM26-524
EWNM26-624
EWNM26-820
EWNM26-1018

PROCEDURES: (Continued)

1. Test Components (Continued)

1.3 Plain, and Countersunk Washers

1.3.1 NAS 1587 stainless steel washers (Fig. 1)

<u>Plain Washers</u>	<u>Countersunk Washers</u>
NAS 1587-4	NAS 1587-4C
NAS 1587-5	NAS 1587-5C
NAS 1587-6	NAS 1587-6C
NAS 1587-8	NAS 1587-8C

1.3.2 A286 washers

5/8 inch plain, and countersunk washers were made to accommodate the larger head and nut diameters of the 5/8 inch bolts, since the diameter of the NAS 1587 washer was not compatible with the nuts tested. The A286 material was in the solution treated condition, and the NAS 1587 "A" diameter was changed to 1 1/4 inches, and the "D" thickness to 3/32 inches. (Figure 1)

1.4 7075-T6 Aluminum Joint Material

1.4.1 1/8 inch thick 7075-T6 aluminum was cut into 1 inch, and 1 1/4 inch wide by 10 inch long strips. 1/4, 5/16, and 3/8 inch holes were drilled on 1 inch centers in the 1 inch wide strips, and 1/2, and 5/8 inch holes were drilled on 1 1/4 inch centers in the 1 1/4 inch wide strips.

2. Test Program

2.1 Schedule of tests for each size bolt, nut, washer, and aluminum joint material:

<u>Bolt</u>	<u>Nut</u>	<u>Nut Lubricant</u>	<u>Number of Tests</u>	
			<u>Torque-Tension</u>	<u>Bolt Tensile</u>
A286	61170C	Cadmium Plate	5	3
A286	61170M	620c dry film	5	
A286	61170C	Cadmium Plate, & cetyl alcohol	5	1*

* Where an additional lot of A286 bolts was procured to determine the effects of cetyl alcohol on torque-tension properties, one bolt was tensile tested to verify ultimate tensile strength.

MP35N	EWNM 26	Cadmium Plate	5	3
MP35N	EWNM 26	620c dry film	5	

PROCEDURES: (Continued)

3. Calibration

- 3.1 The torque, and pounds force load cells used in this test program were calibrated in accordance with SPS Calibration Procedures report CP-21 just prior to testing.
- 3.2 Tensile machines are verified monthly according to SPS Calibration Procedures CP-1

4. Test Procedures

4.1 Ultimate Tensile Strength

- 4.1.1 The bolts outlined in 1.1, and the companion nuts outlined in 1.2.1 were tested in the 60,000, and 120,000 pounds Tinius Olsen tensile machines. Load versus elongation curves were plotted on an X-Y recorder, and the proportional limit yield strength was approximated at the maximum load within the elastic limit.

4.2 Joint Bearing Stress

4.2.1 Joint Material

- 4.2.1.1 The minimum load to cause the NAS 1587 washers to begin brinelling into the 7075-T6 aluminum joint material was determined by loading the joint in 1000 pound increments, and examining the aluminum surface after each loading until the minimum load where the washers brinelled into the aluminum was determined. (Table III)

4.2.2 NAS 1587 Washers

- 4.2.2.1 The minimum load to cause the bolt head of the A286, and MP35N bolts to begin brinelling into the NAS 1587 countersunk washers was determined by loading each bolt head against a washer in 1000 pound increments, and examining the washer after each loading until the minimum load to brinell the washer was determined.
- 4.2.2.2 The minimum pounds to cause the 61170, and EWNM 26 nuts to brinell in the NAS 1587 plain washers was determined by loading each nut against a washer in 1000 pound increments, and examining the washer after each loading until the minimum load to brinell the washer was determined. (Tables IV, and V)

PROCEDURES: (Continued)

4. Test Procedures (Continued)

4.3 Torque Versus Induced Load

4.3.1 G.M. Torque-Tension Machine (Figures 2, and 3)

The 1/4 through 1/2 inch sizes were tested in the G.M. Torque-Tension machine which has a 4,000 inch pounds maximum torque and a 60,000 pounds maximum tension capability. The rate of loading was controlled at 2 RPM.

4.3.2 SPS Torque-Tension Machine

The 5/8 inch A286 bolts were tested in the SPS Torque-Tension machine which has a 10,000 inch pounds torque, and a 40,000 pounds maximum tension capability. The rate of loading was controlled at 2 RPM.

4.3.3 Tinius Olsen Torque Machine

The 5/8 MP35N bolts were tested in a 60,000 inch pound Tinius Olsen torque machine, using a 60,000 pound tension load cell. The rate of loading was 1/2 RPM, the maximum available speed.

4.4 Torque-Tension set up

4.4.1 Each bolt was assembled in the tension load cell with a NAS 1587 countersunk washer under head, and with the 7075-T6 aluminum joint material, and a NAS 1587 plain washer under the companion nut. (Figure 3).

The head was retained from turning, and torque was applied, turning the nut against the plain washer. By this arrangement the test bolt, nut, washers, and the aluminum joint material were tested as a unit.

4.4.2 Torque vs. Induced Load Curves

4.4.2.1 The torque-tension curves for each of the five bolts tested were recorded by the torque-tension machine's X-Y recorder. Then, data points from the five curves were replotted on a single chart. The recommended seating torque selected was that point where the mean of the induced loads was 90,000 psi tensile stress in the bolt threads.

Other data points can be selected from the torque-tension curves by the same method.

DISCUSSION OF RESULTS:

When high strength fasteners such as 200 KSI A286, and 260 KSI MP35N nut, and bolt combinations are used to preload a joint consisting of low strength NAS 1587 washers, and 7075-T6 aluminum joint material it is essential to include them in the torque-tension test joint.

The torque-tension joint study conducted revealed that the 7075-T6 aluminum joint material, and the NAS 1587 washers maximum allowable bearing stress was approximately 40,000 psi, occurring at about 100,000 psi bolt preload for both the A286 and MP35N nuts, and bolts (Tables III, IV, and V), thereby limiting the joint clamping load to 90,000 psi. Increased washer strength, and area should be considered when greater bolt preload is required.

COUNTERSUNK WASHER
FOR USE UNDER BOLT HEAD

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PLAIN WASHER
FOR USE UNDER NUT

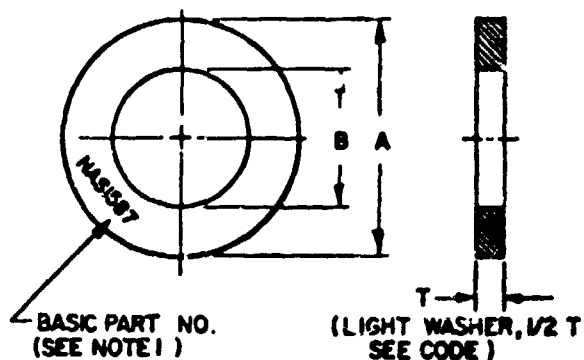
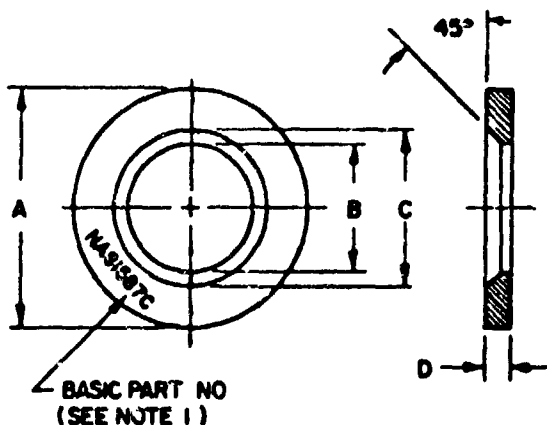


TABLE 1

DASH NO.	THREAD SIZE (REF.)	A DIA	B DIA		C DIA		D	FLATNESS TOLERANCE MAXIMUM	T
			MAX	MIN	MAX	MIN			
① A3C	.190	.469	.198	.192	.285	.275	.062	.007	
-3	.190	.469	.198	.192	.285	.275	.062	.007	.032
-4	.250	.531	.260	.252	.344	.334	.078	.007	.062
-5	.312	.593	.324	.315	.406	.396	.078	.007	.062
-6	.375	.687	.388	.378	.495	.483	.078	.007	.062
-7	.437	.781	.451	.441	.557	.543	.078	.007	.062
-8	.500	.875	.515	.504	.620	.604	.078	.007	.062
-9	.562	.968	.579	.568	.687	.667	.078	.010	.062
-10	.625	1.062	.643	.631	.785	.765	.078	.010	.062
-12	.750	1.250	.770	.757	.910	.890	.078	.010	.062
-14	.875	1.437	.897	.884	1.035	1.015	.078	.010	.062
-16	1.000	1.625	1.025	1.010	1.160	1.140	.078	.010	.062
-18	1.125	1.875	1.150	1.135	1.265	1.265	.078	.010	.062
-20	1.250	2.125	1.275	1.260	1.447	1.427	.094	.010	.062

- ① CODE: DAS NUMBER DESIGNATES THREAD SIZE.
ADD "C" AFTER DASH NUMBER TO DESIGNATE COUNTERSUNK WASHER.
ADD "L" AFTER DASH NUMBER TO DESIGNATE LIGHT WASHER, THICKNESS OF 1/2T.
ADD "A" BEFORE "C" TO DESIGNATE A COUNTERSUNK WASHER SUITABLE FOR USE WITH .190 DIAMETER JMSION FATIGUE BOLT (NECESSARY FOR THIS SIZE ONLY).

PART NUMBER EXAMPLE: NAS 1587-4C
COUNTERSUNK WASHER
WASHER FOR 1/4 THD SIZE
BASIC PART NUMBER

NAS 1587-4L
LIGHT WASHER (.031 THK)
WASHER FOR 1/4 THD SIZE
BASIC PART NUMBER

MATERIAL: CORROSION RESISTANT STEEL PER MIL-S-6721 (TYPE 321 OR 347) OR PER QQ-S-763, CLASS 321 OR 347, COND. A. (75,000 psi UTS Min.)

FINISH: CLEAN AND PASSIVATED IN ACCORDANCE WITH MIL-S-5002.

NOTES: 1. PART NUMBER TO BE INDENTED .010 MAX.

2. WASHER FACES SHALL BE PARALLEL WITHIN .002 INCH.

3. 63 RMR, MAX SURFACE ROUGHNESS AS PER MIL-STD-10A ON BOTH FACES OF WASHER.

4. WASHERS SHALL BE FREE FROM ALL MACHING BURRS AND SLIVERS WHICH MIGHT BECOME DISLOOED UNDER USAGE.

① Δ TYPE "-C" INACTIVE FOR DESIGN AFTER 15 SEPT. 1973. SUPERSEDED BY TYPE "A3C".

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES 2 PLACE = ±.03, 3 PLACE = ±.010, ANGLES = ±1°

Figure 1.

CUSTODIAN: NATIONAL AEROSPACE STANDARDS COMMITTEE

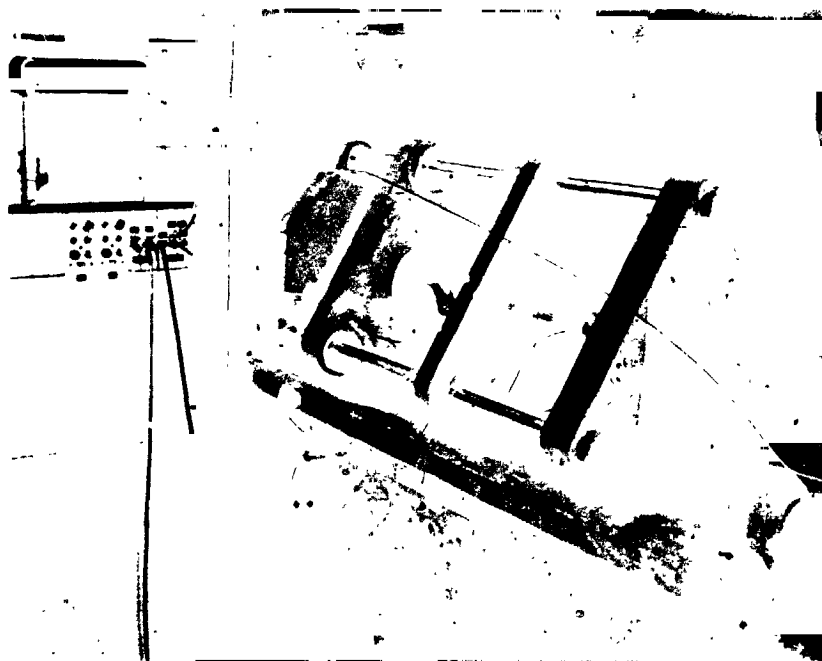
PROCUREMENT
SPECIFICATION
NONE

TITLE
WASHER
PLAIN AND CSK, 1200°F

CLASSIFICATION
STANDARD PART

NAS 1587

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A4936R

Figure 2. G.M. Torque Tension machine and the Moseley 136A X-Y recorder.

BLACK AND WHITE PHOTOGRAPH



A4937R

Figure 3. Photograph of the nut, plain washer, and aluminum joint material in a slotted bushing designed to hold the aluminum strip from turning. Torque was applied from the nut end.

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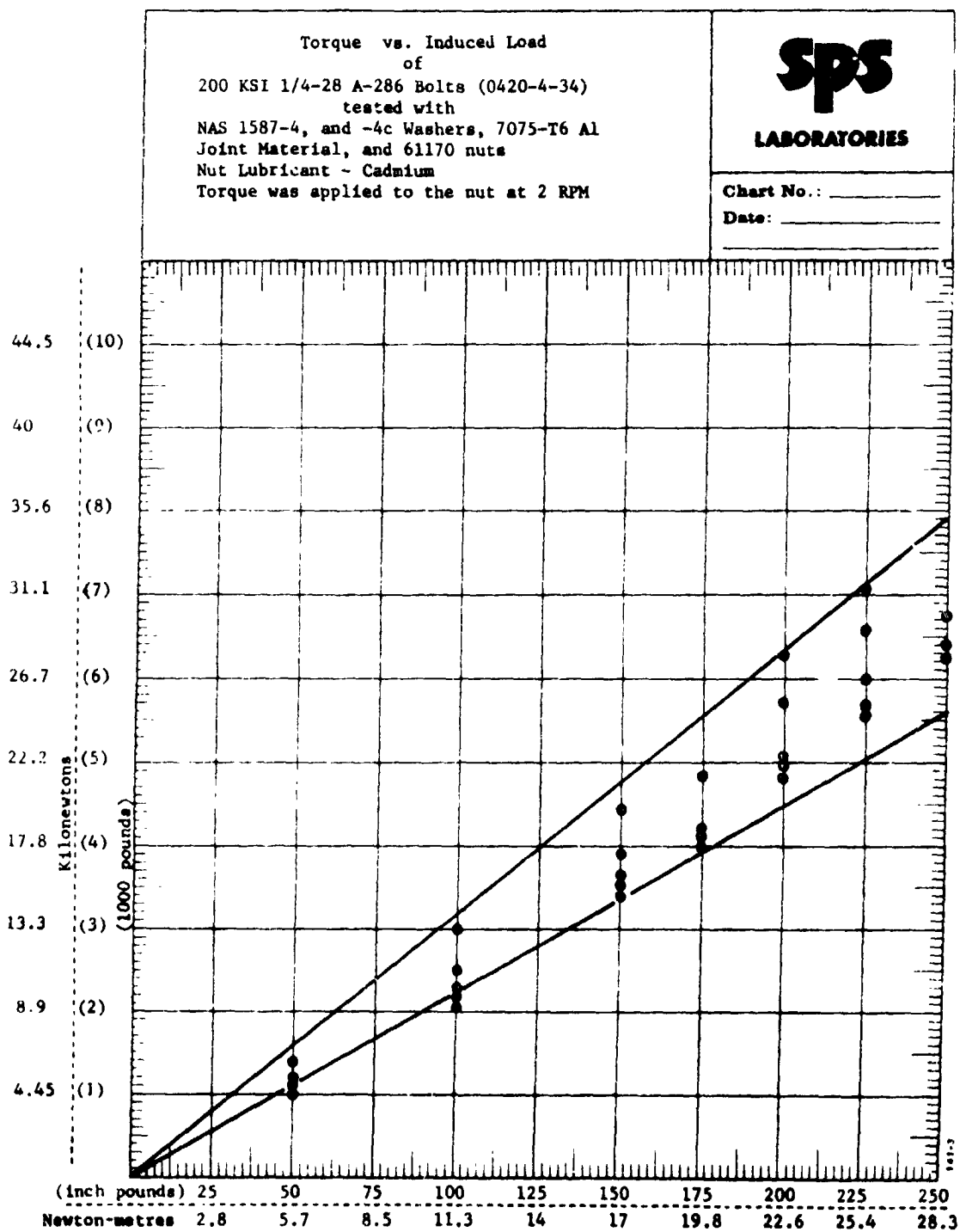


Figure 4.

CRITICAL TORQUE OF POOR QUALITY

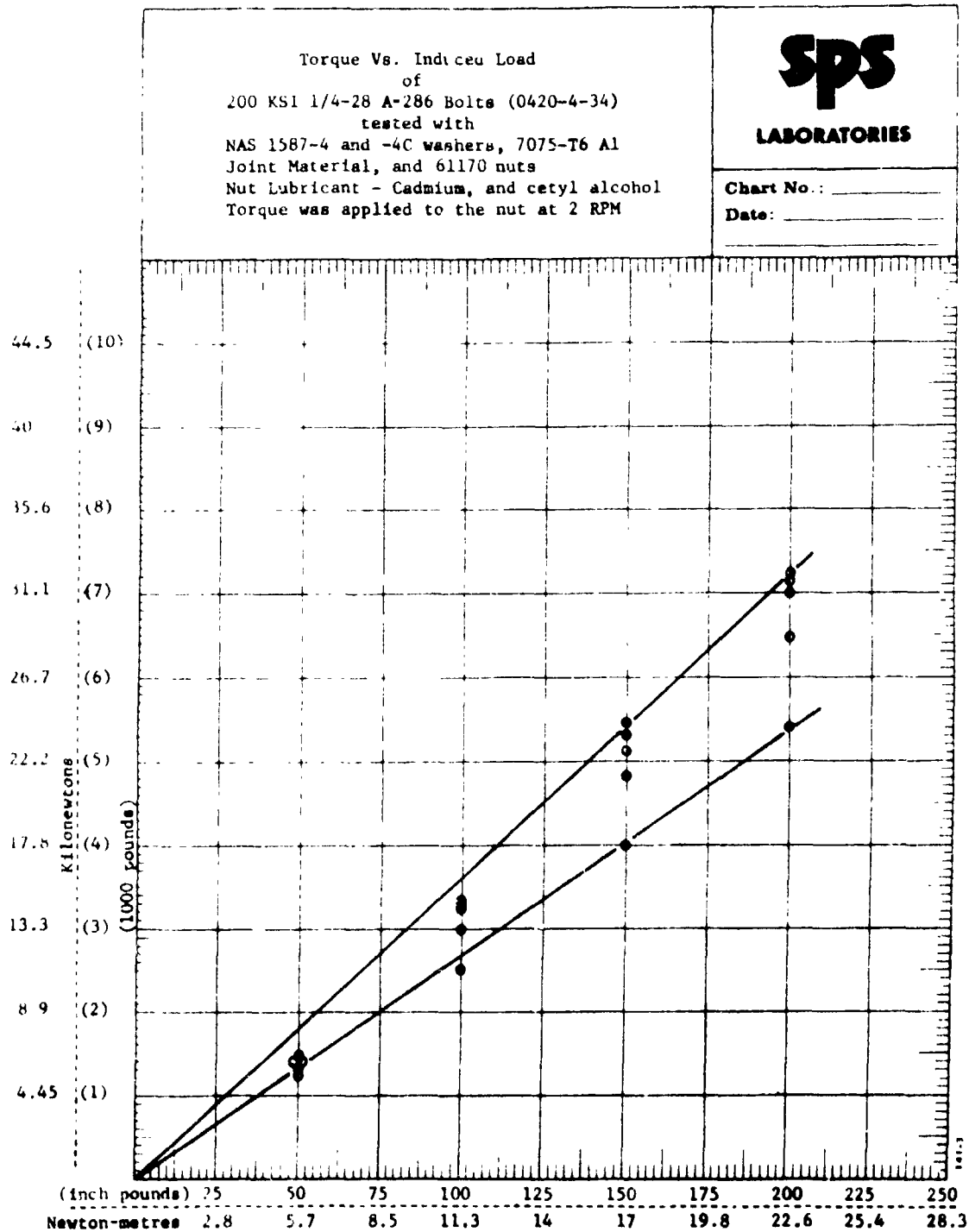


Figure 5.

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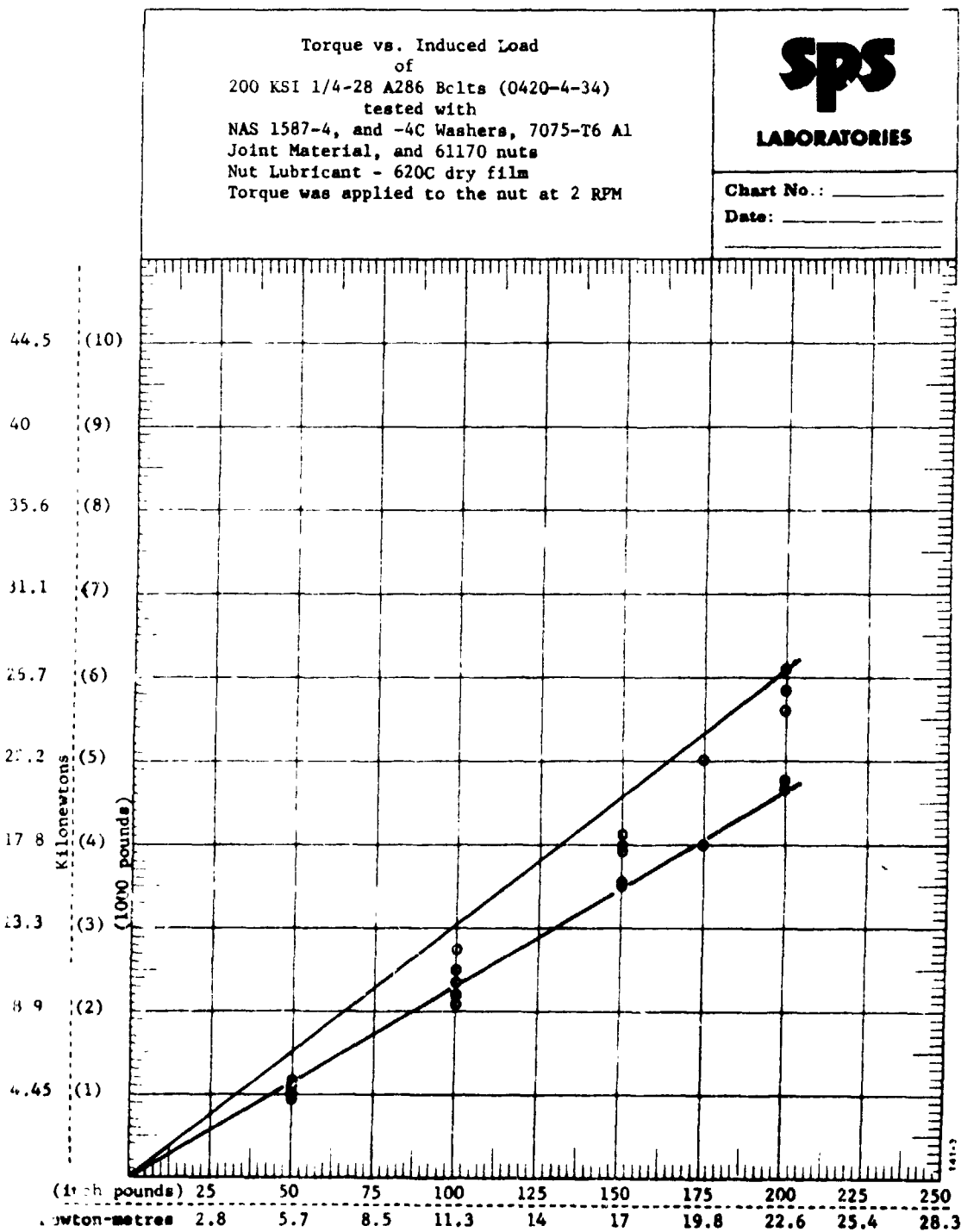


Figure 6.

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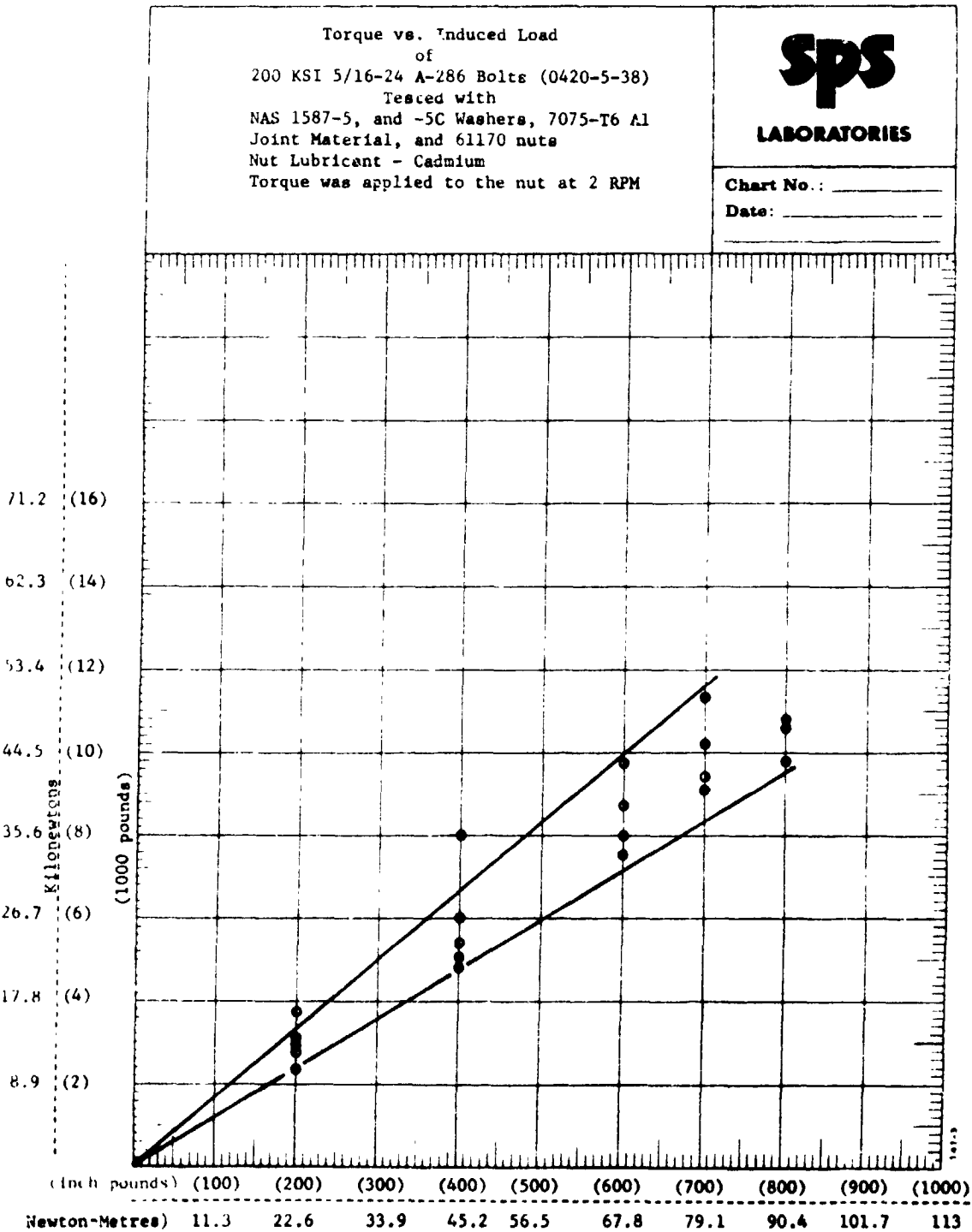


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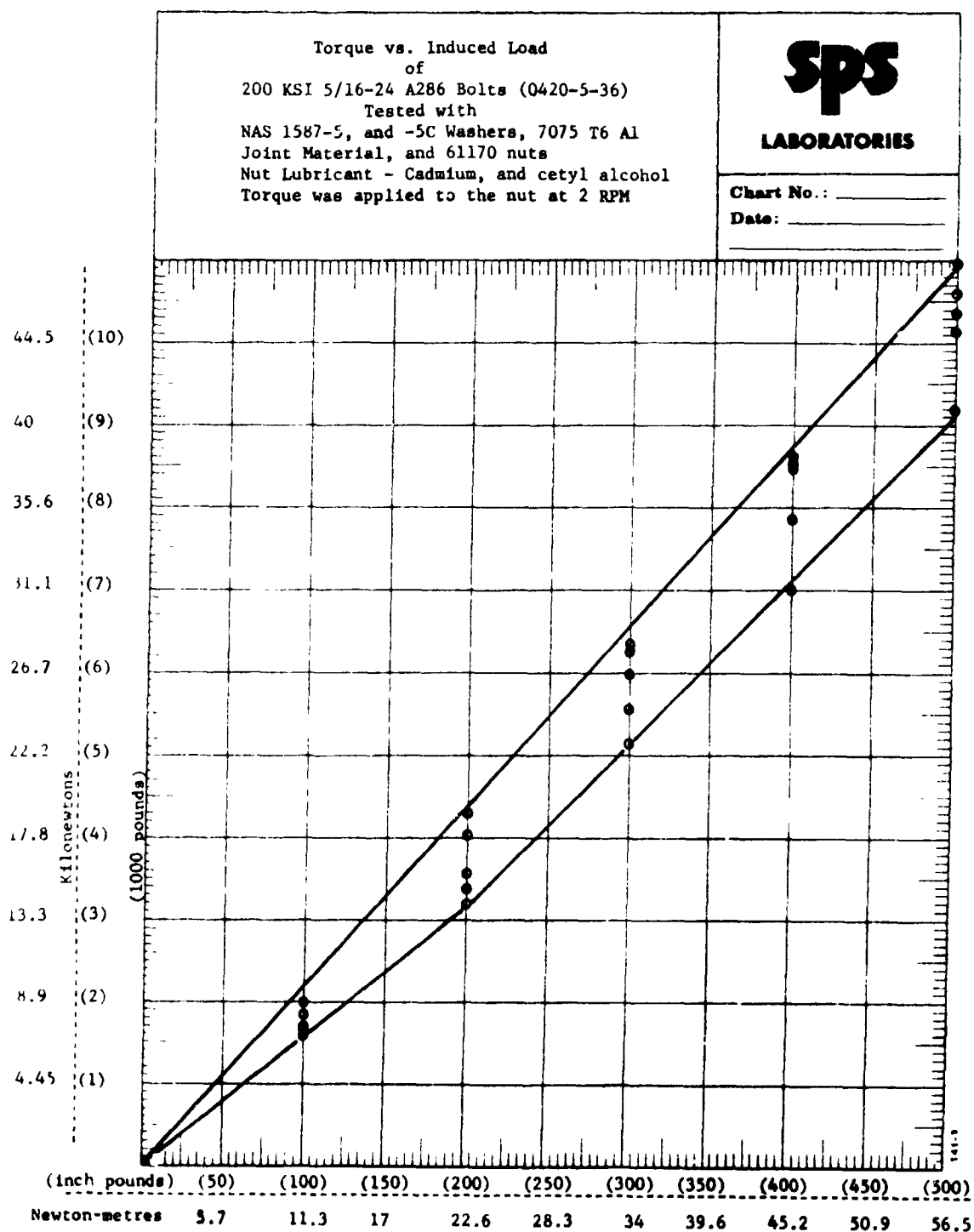


Figure 8.

CRITICAL EFFECTS OF POOR QUALITY

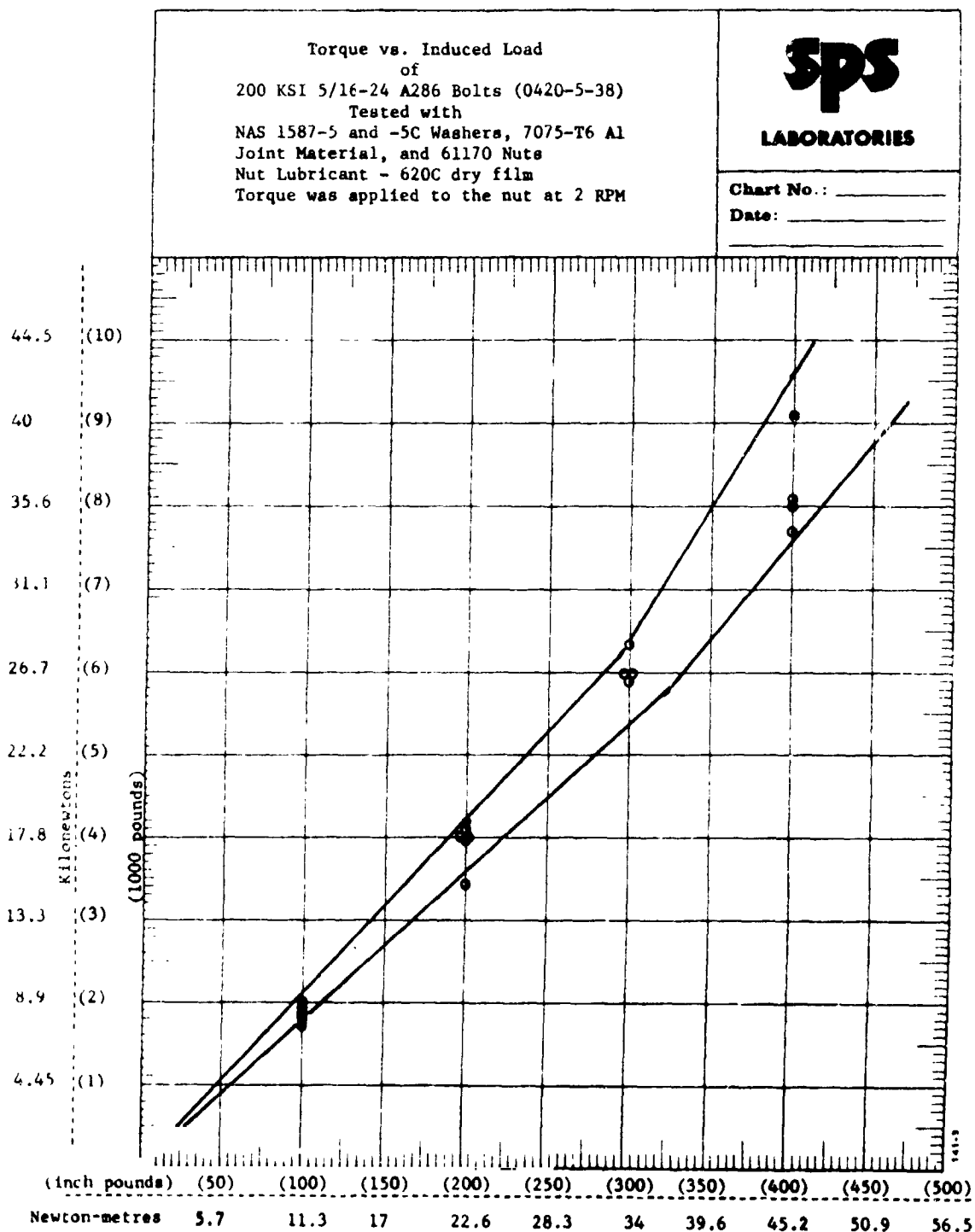


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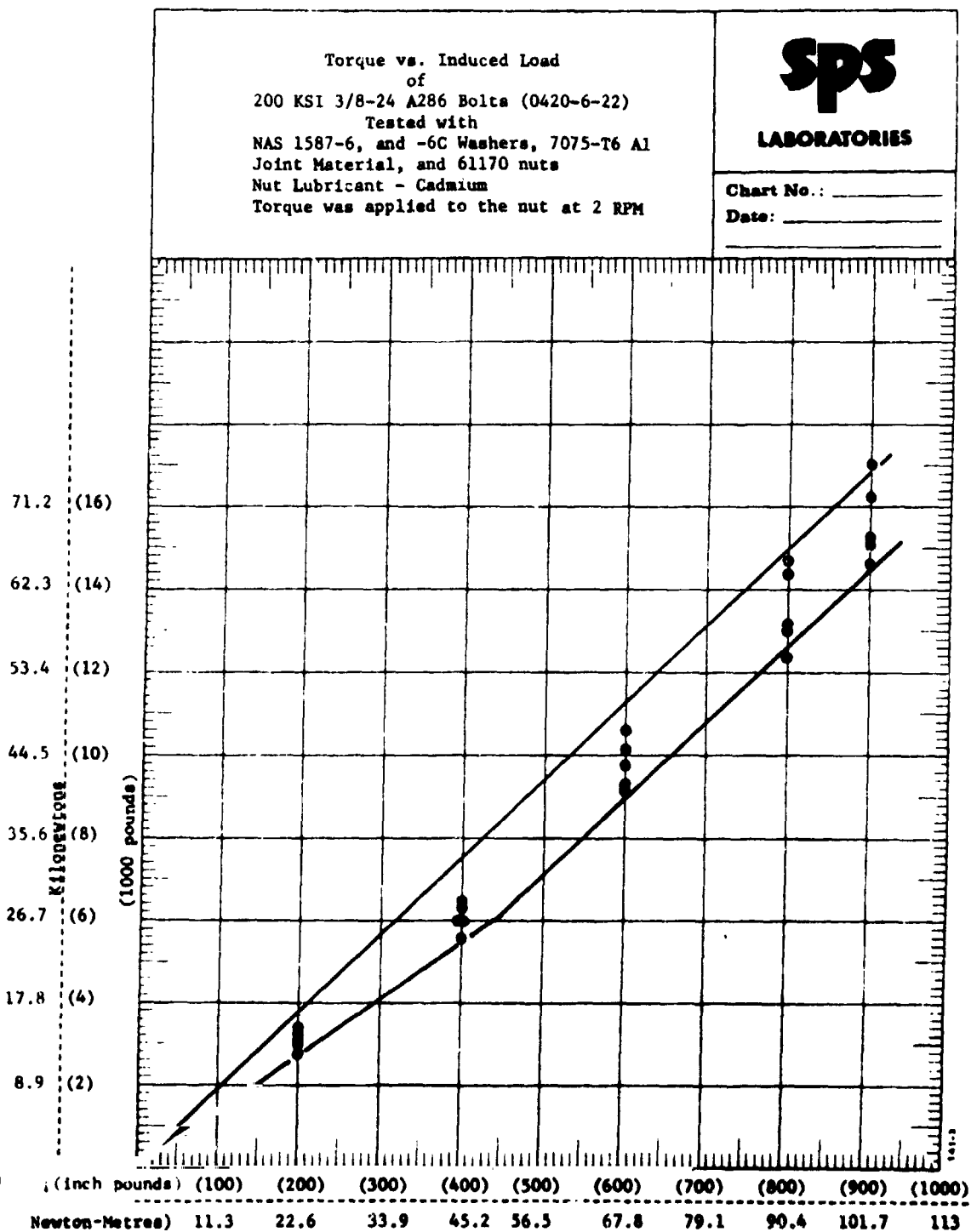


Figure 10.

CRITICAL POINTS
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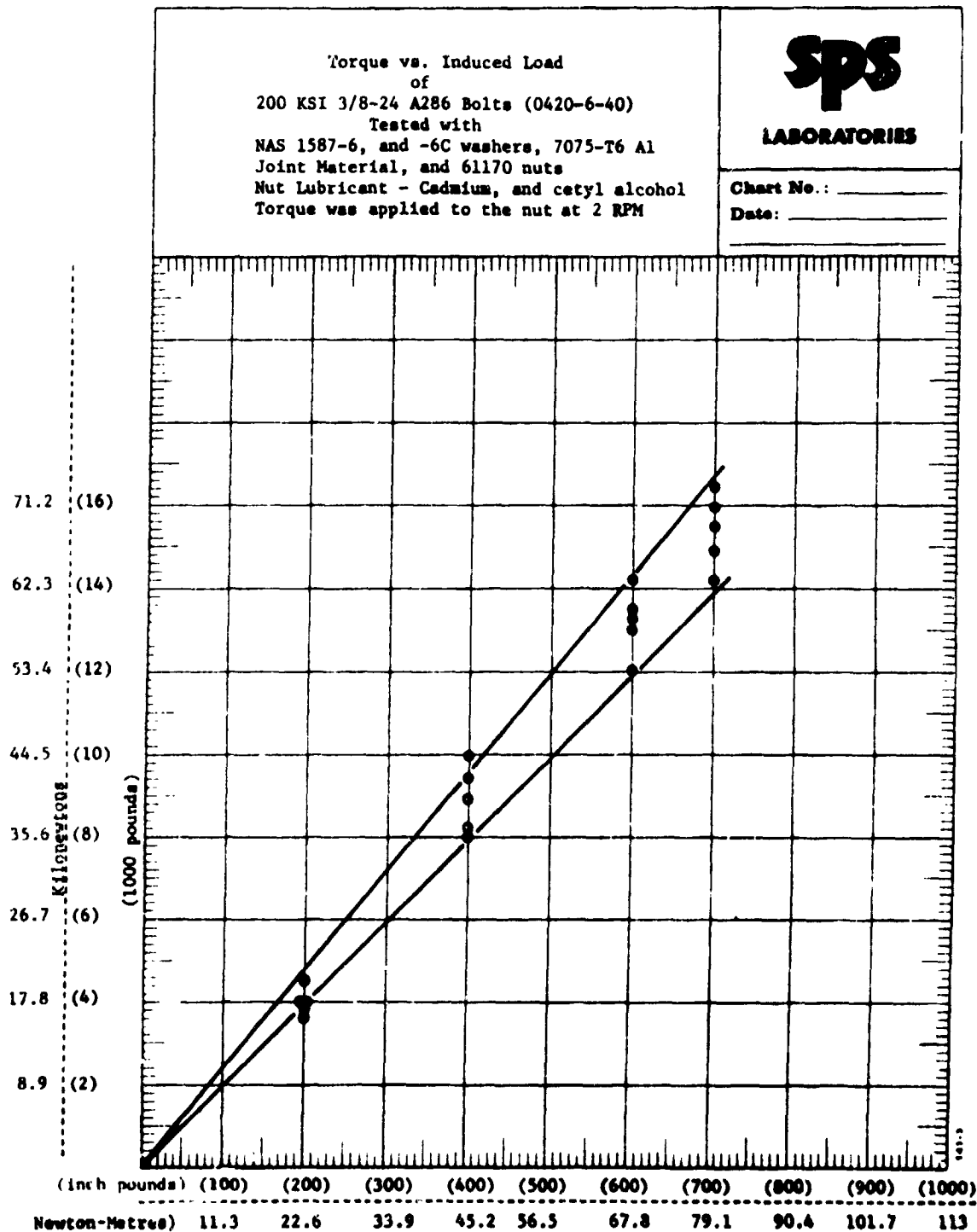
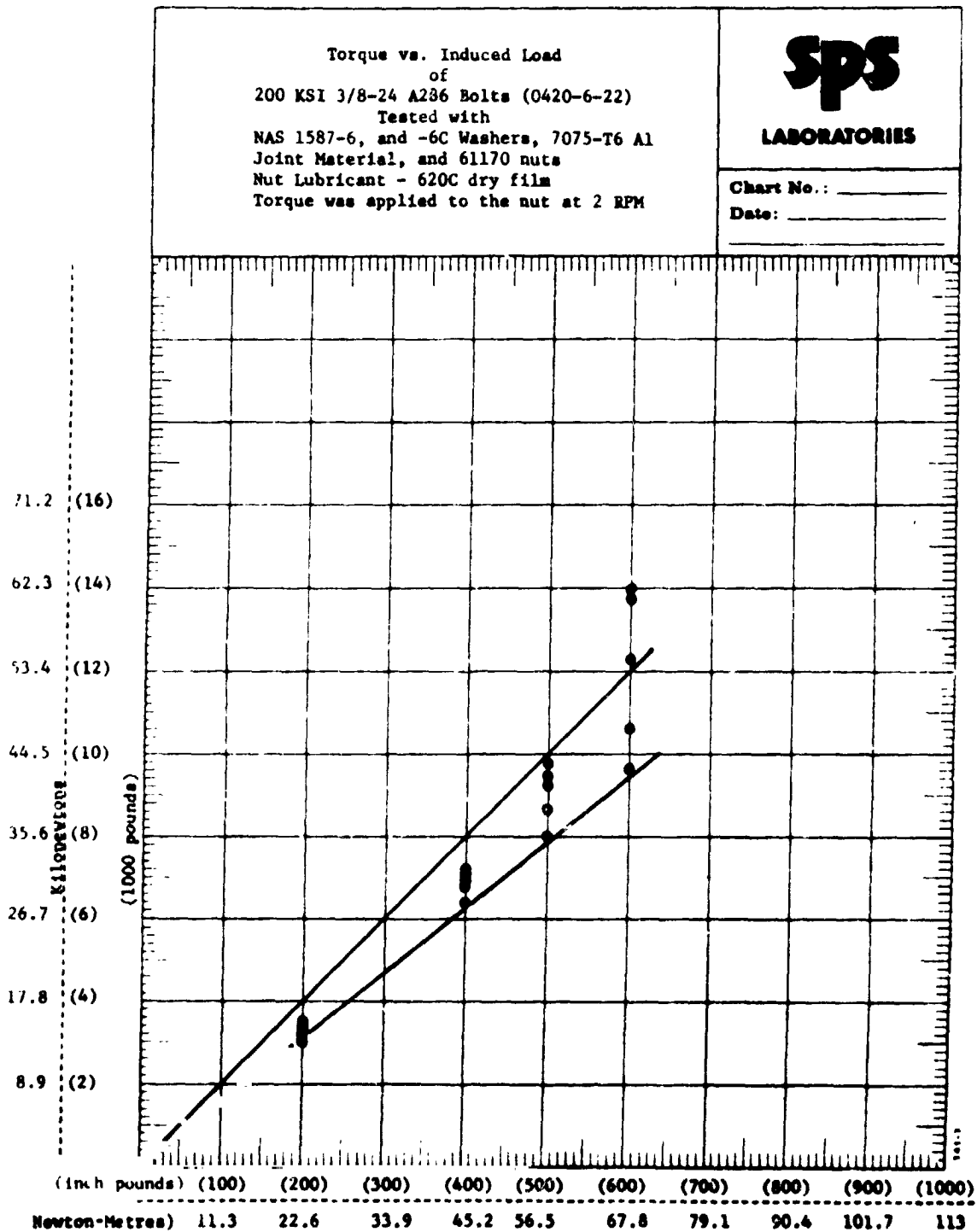


Figure 11.

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CRITICAL SPEEDS
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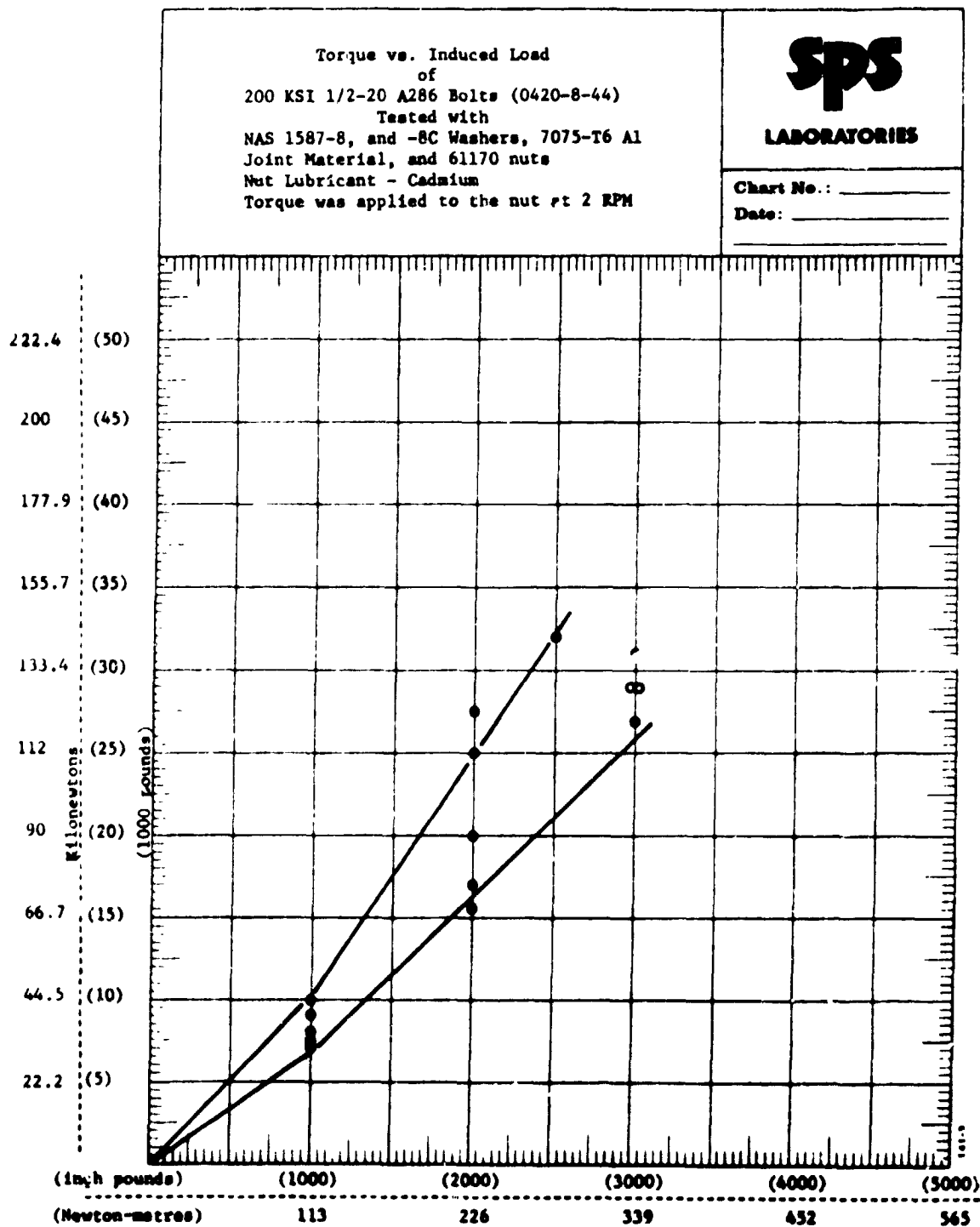


Figure 13.

CHARACTERISTICS
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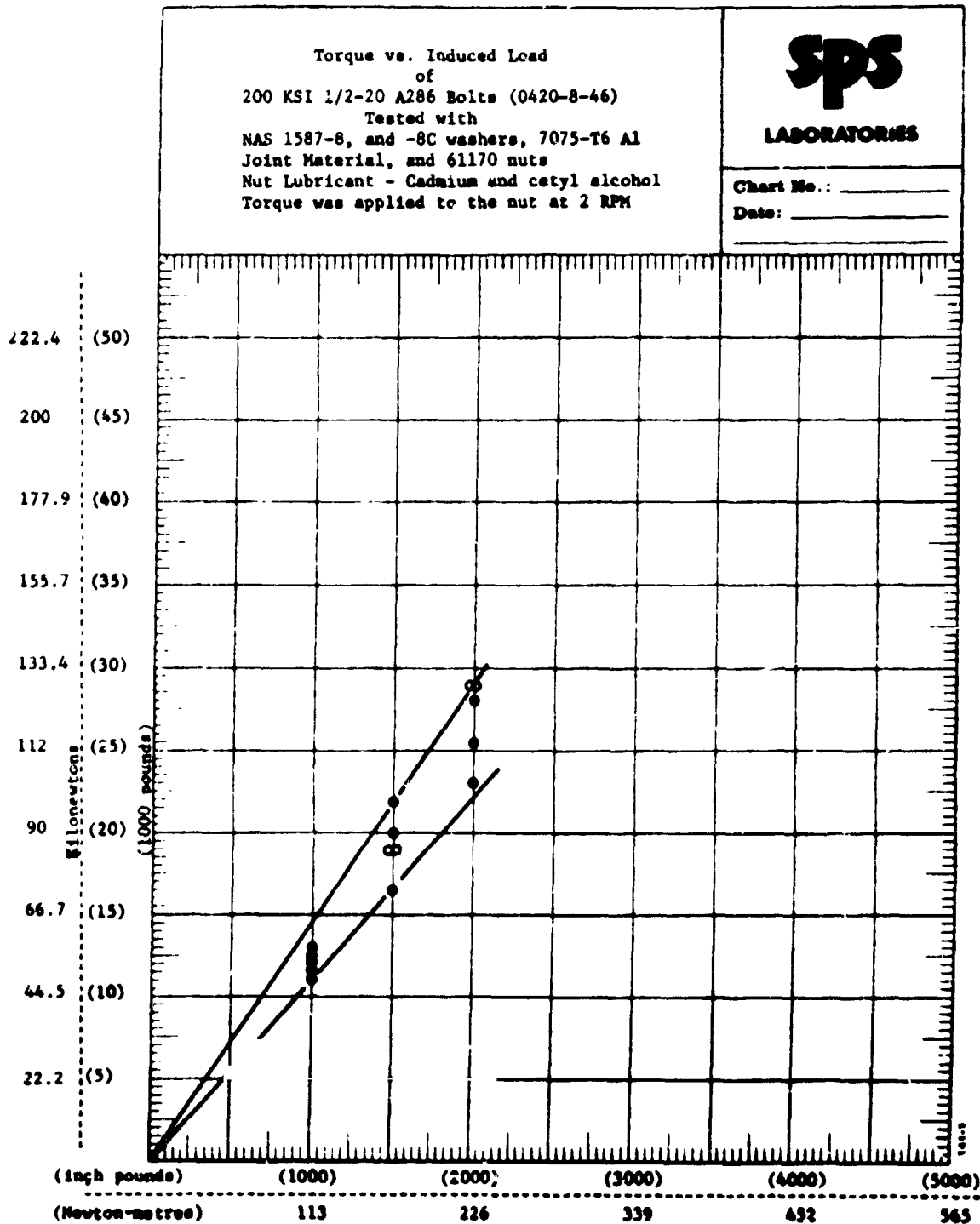


Figure 14.

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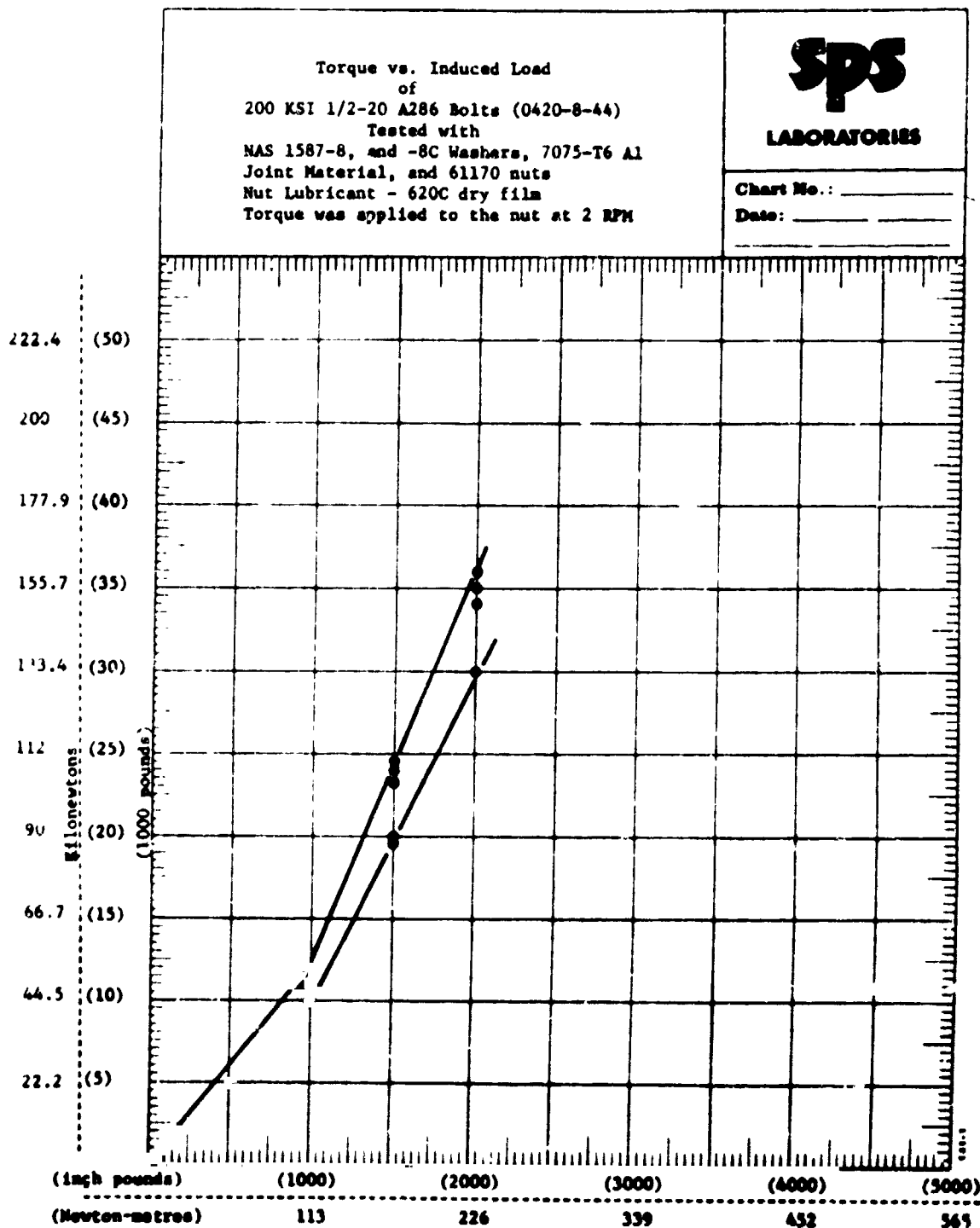


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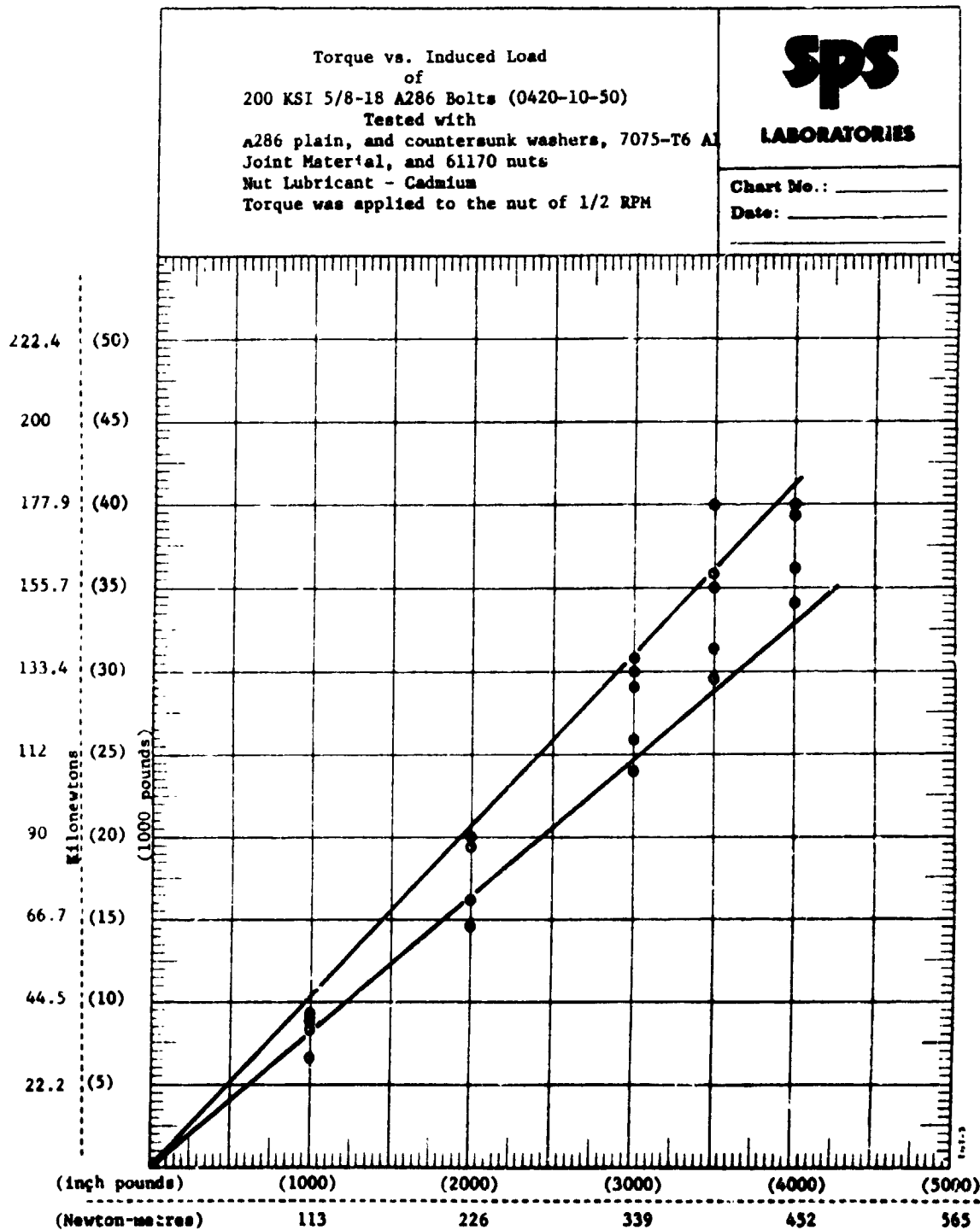


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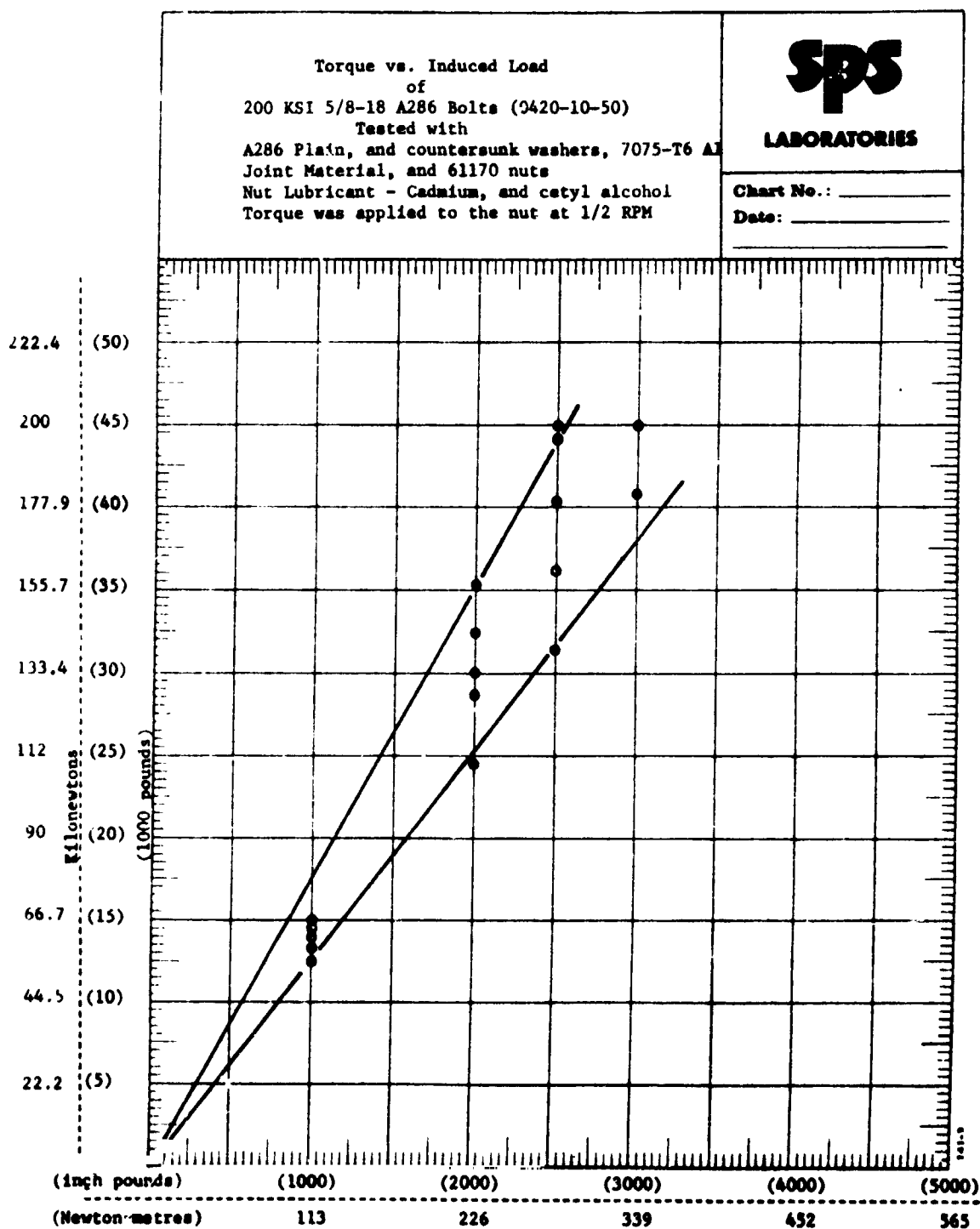


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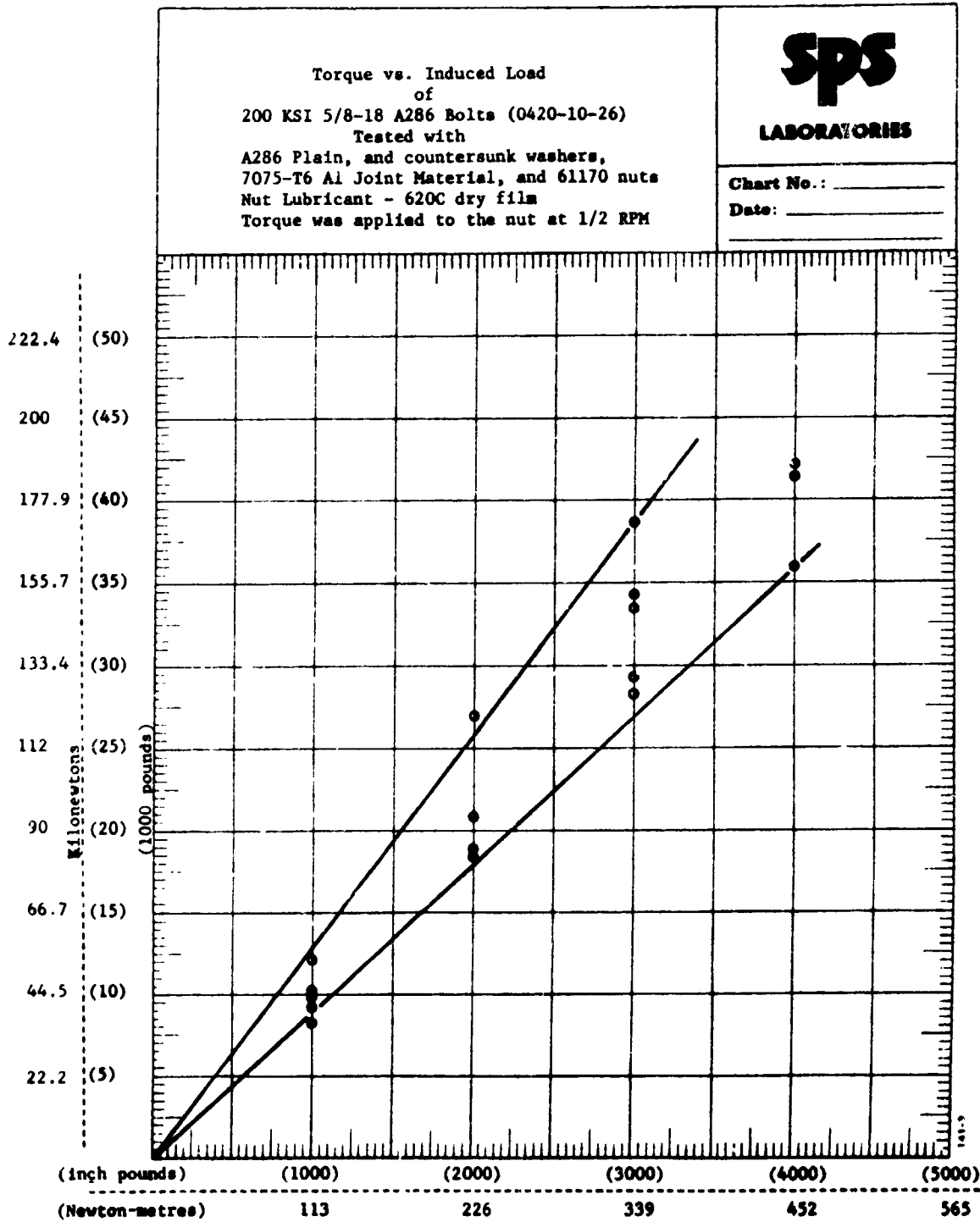


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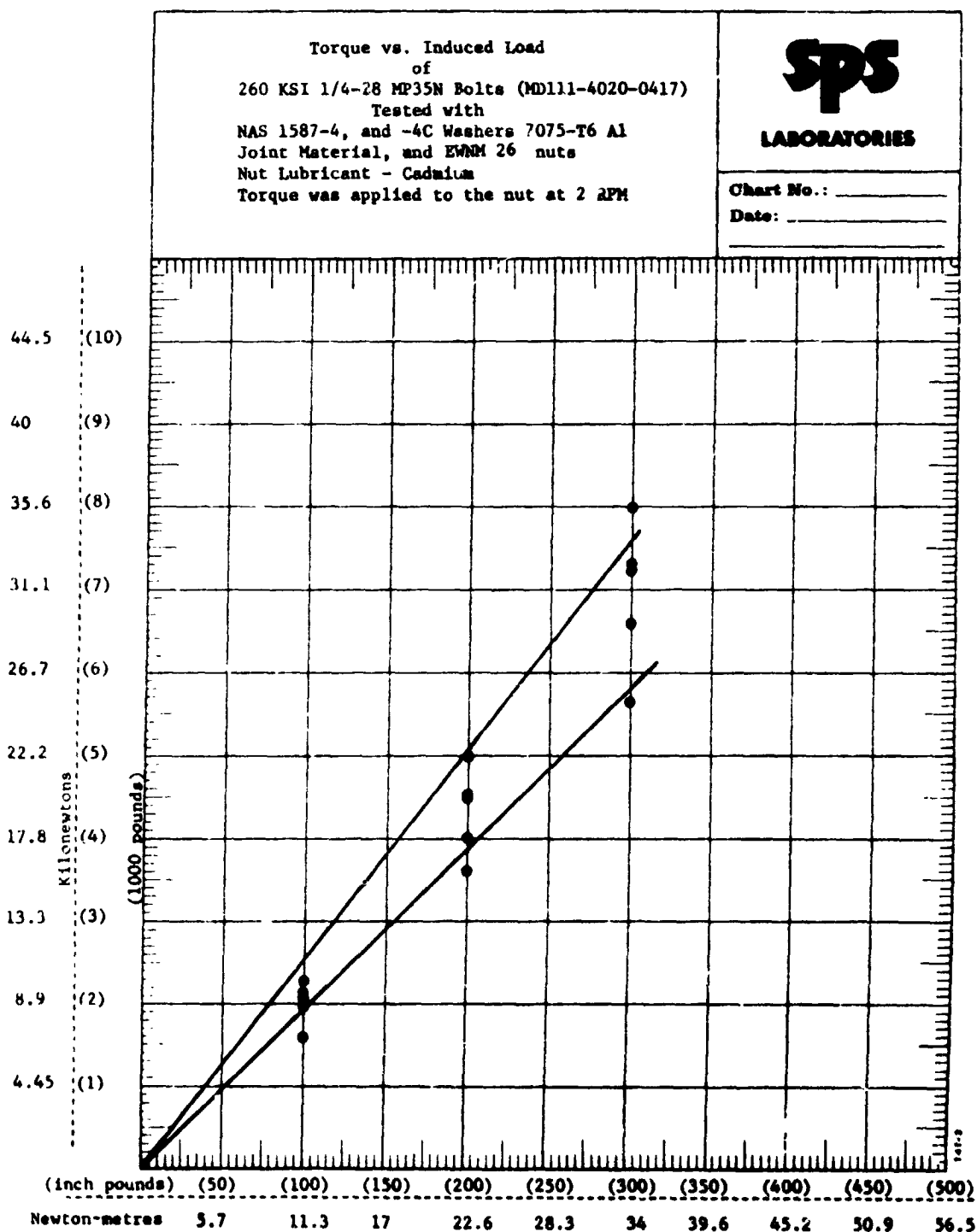


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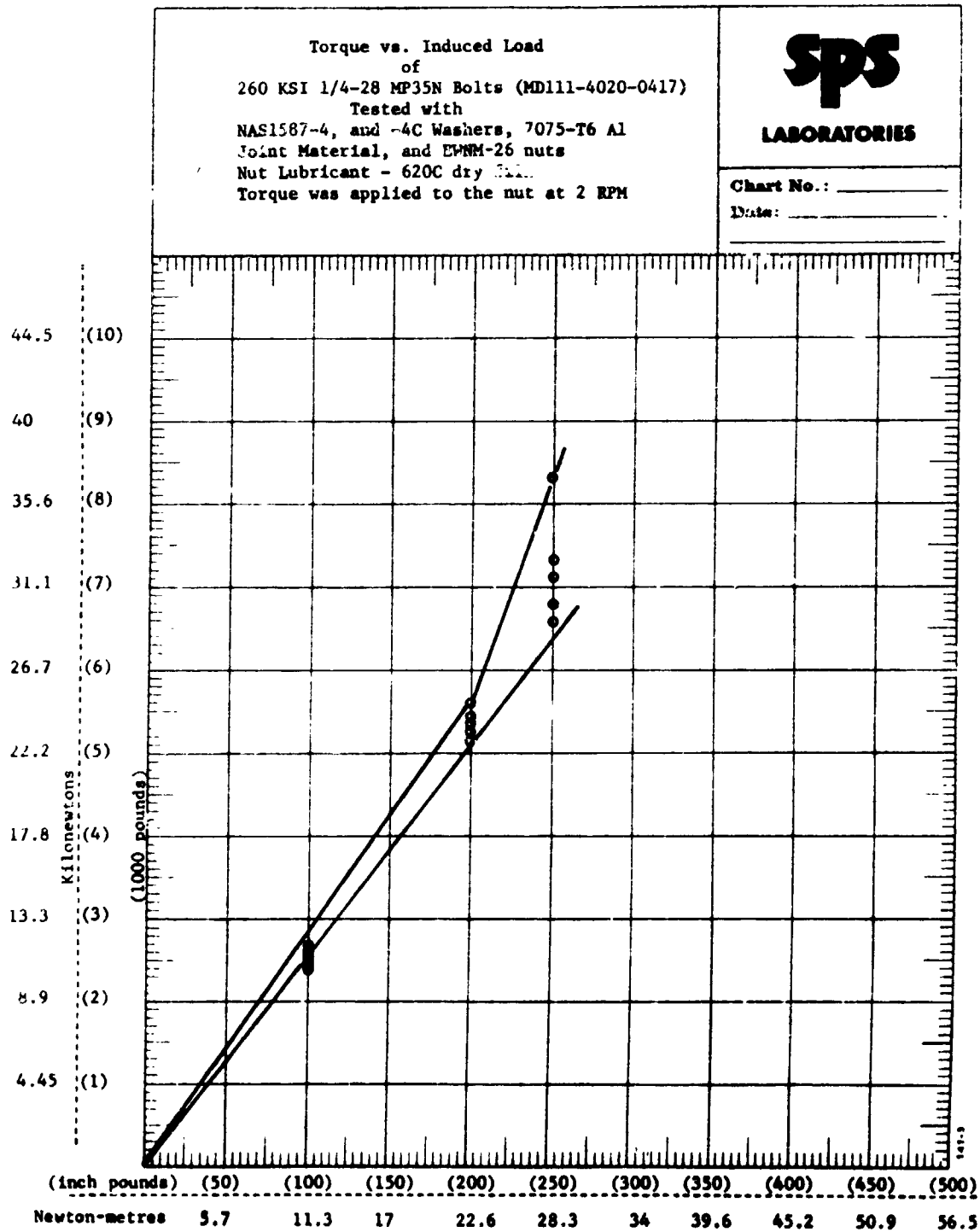


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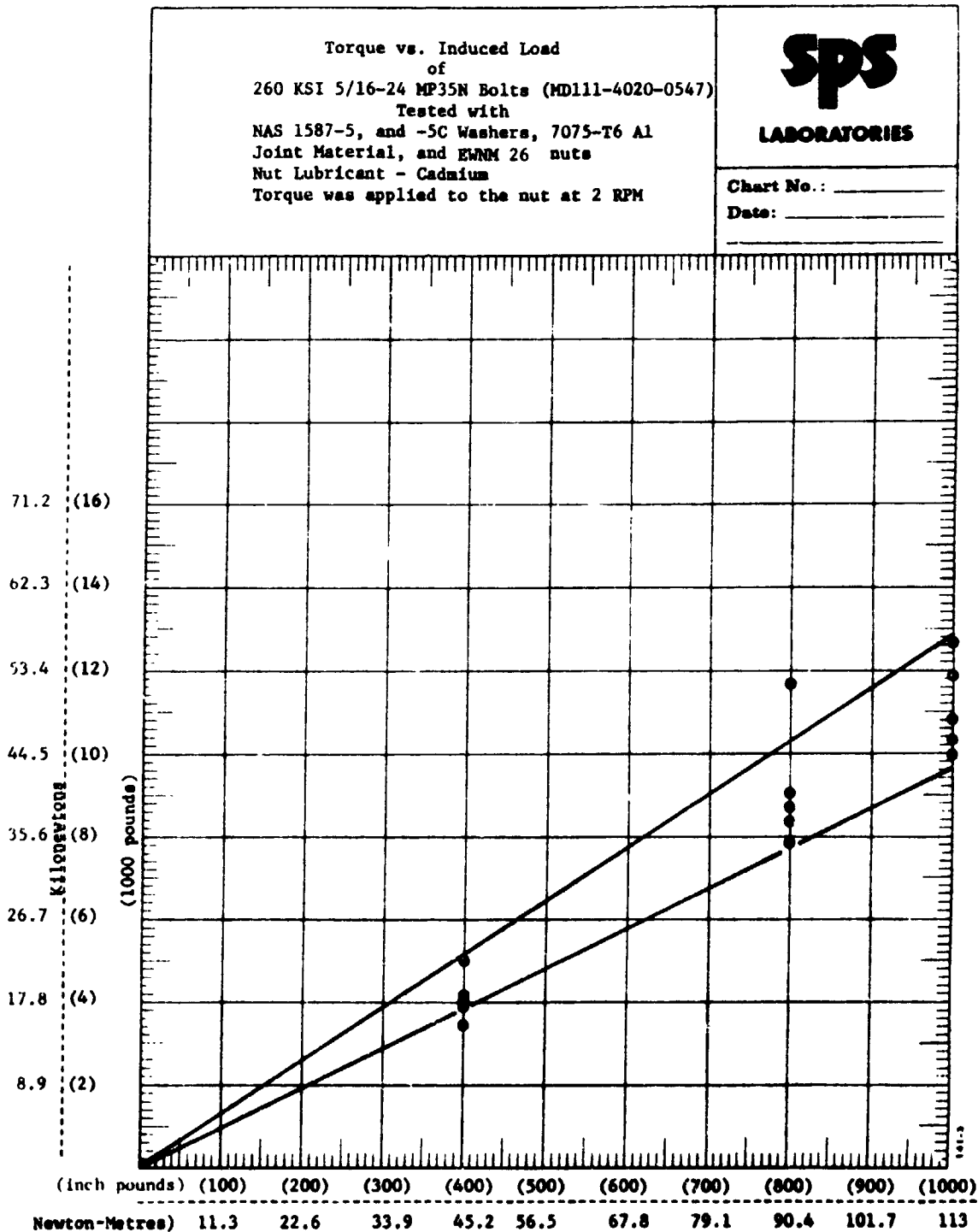


Figure 21.

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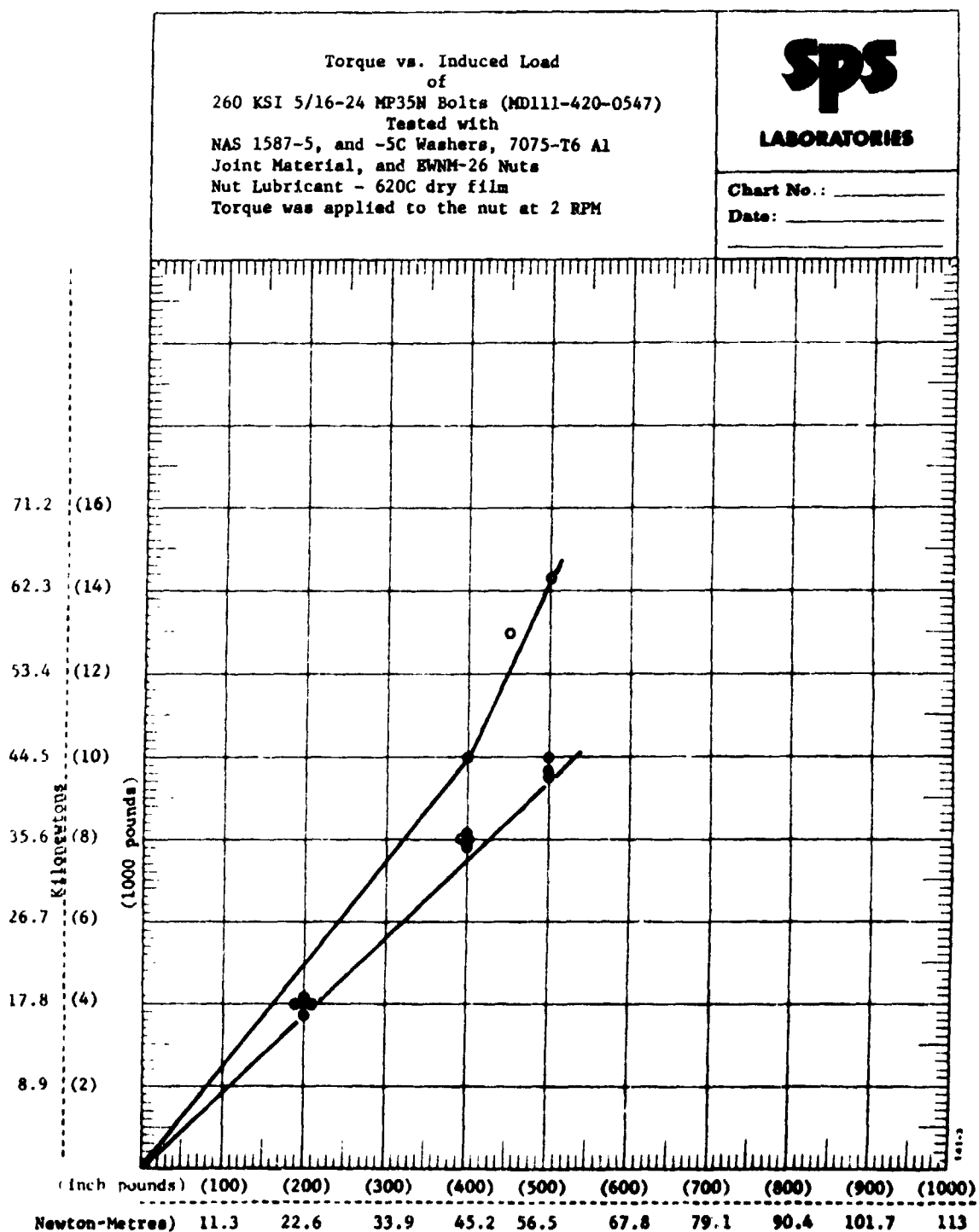


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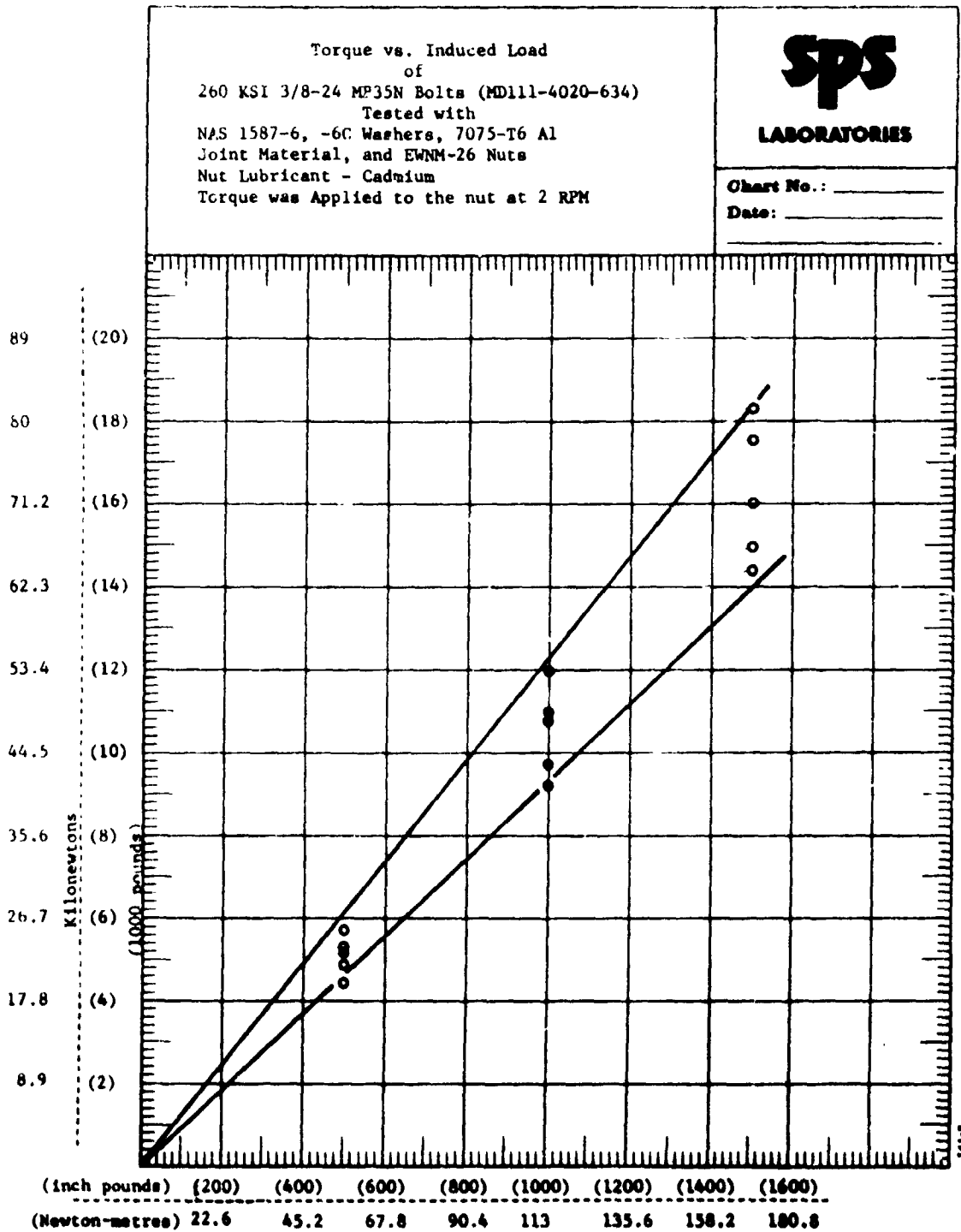


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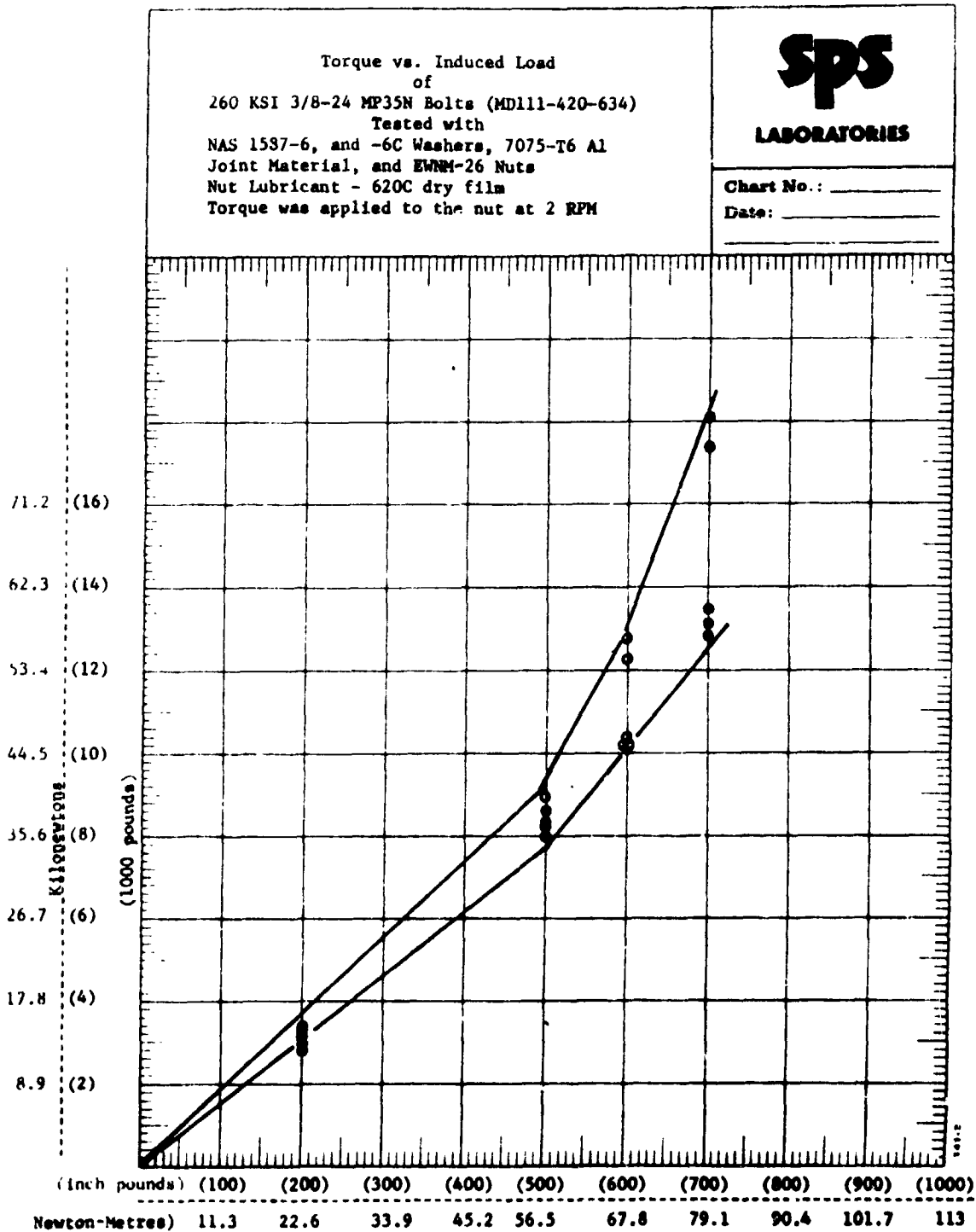


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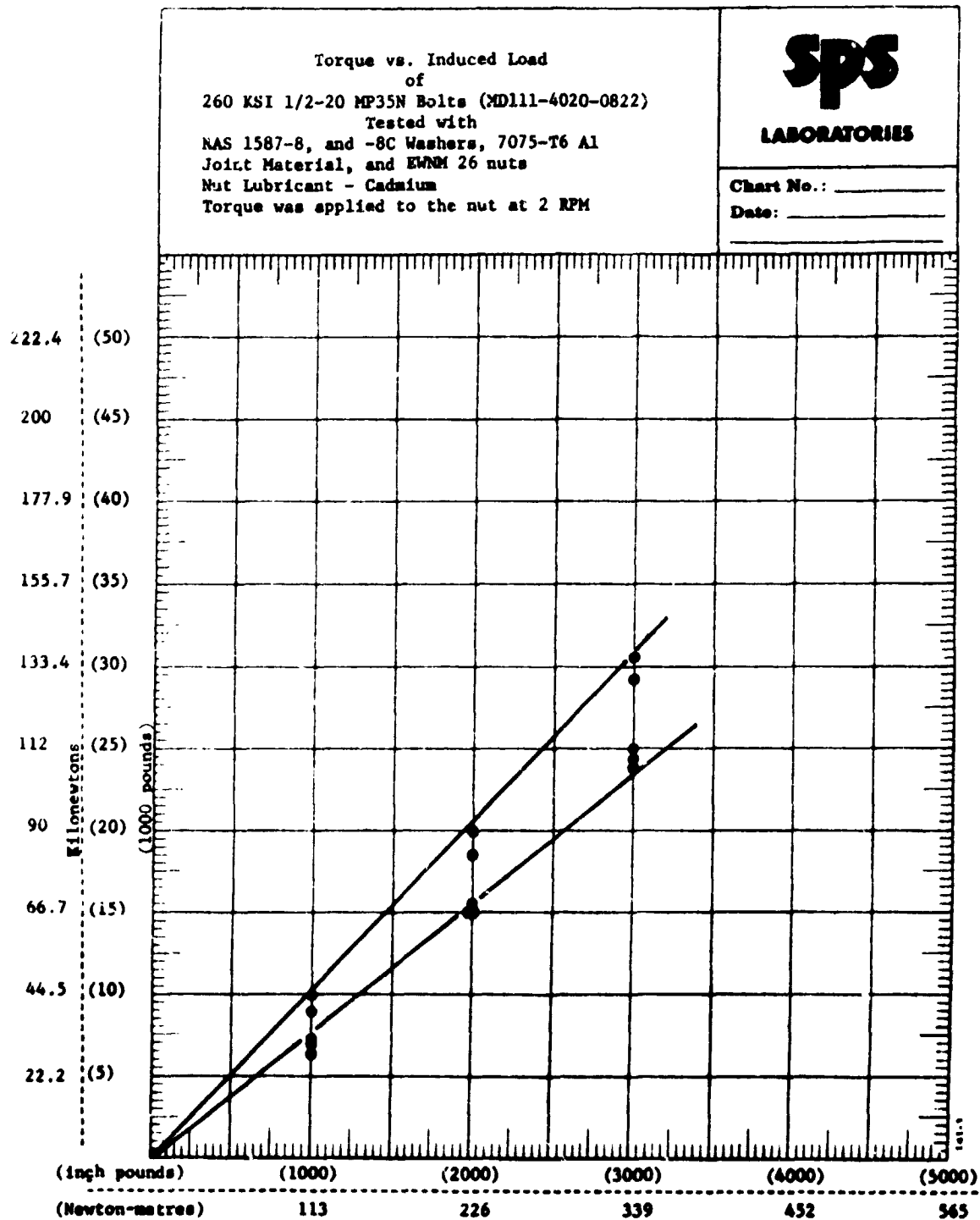
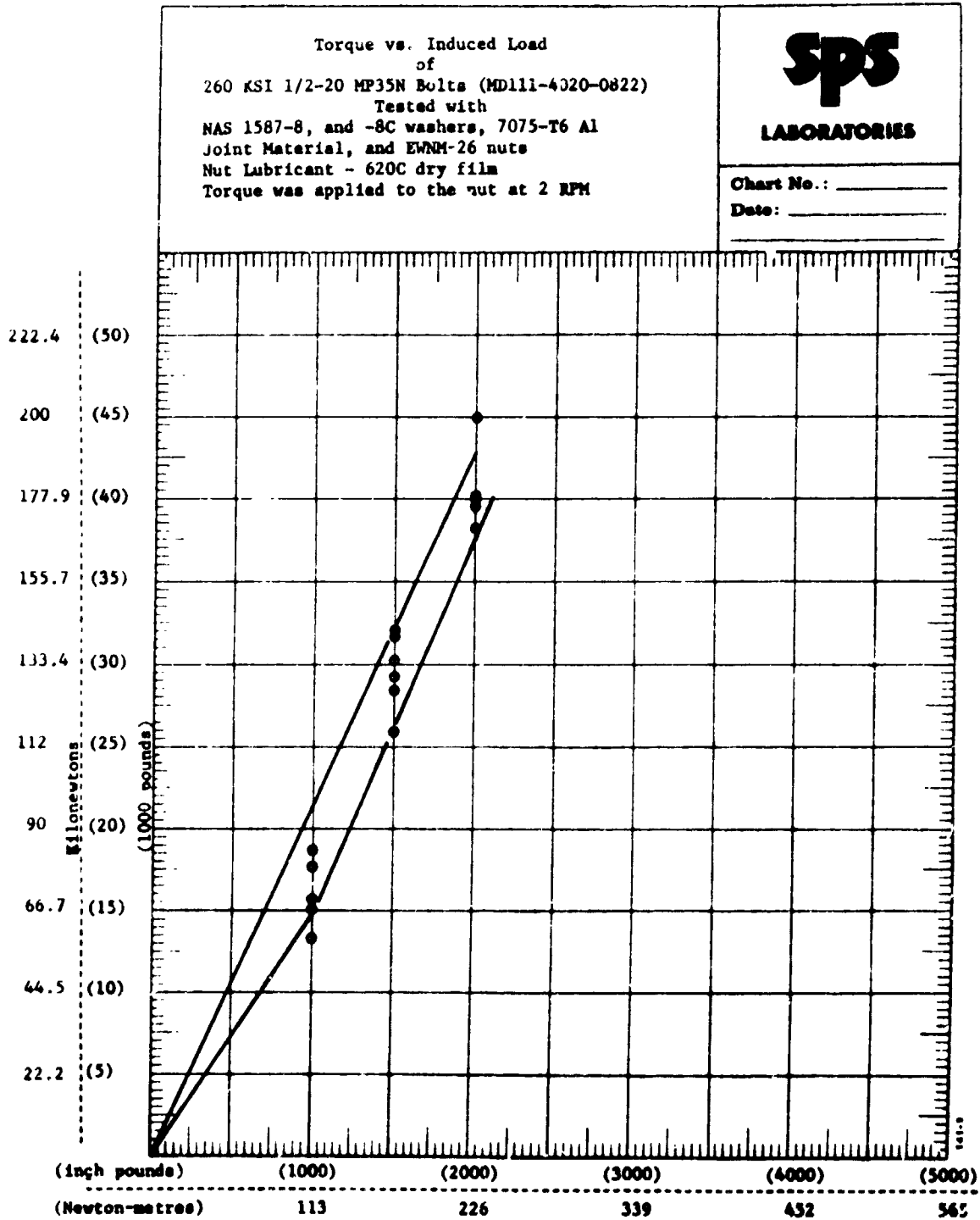


Figure 25.

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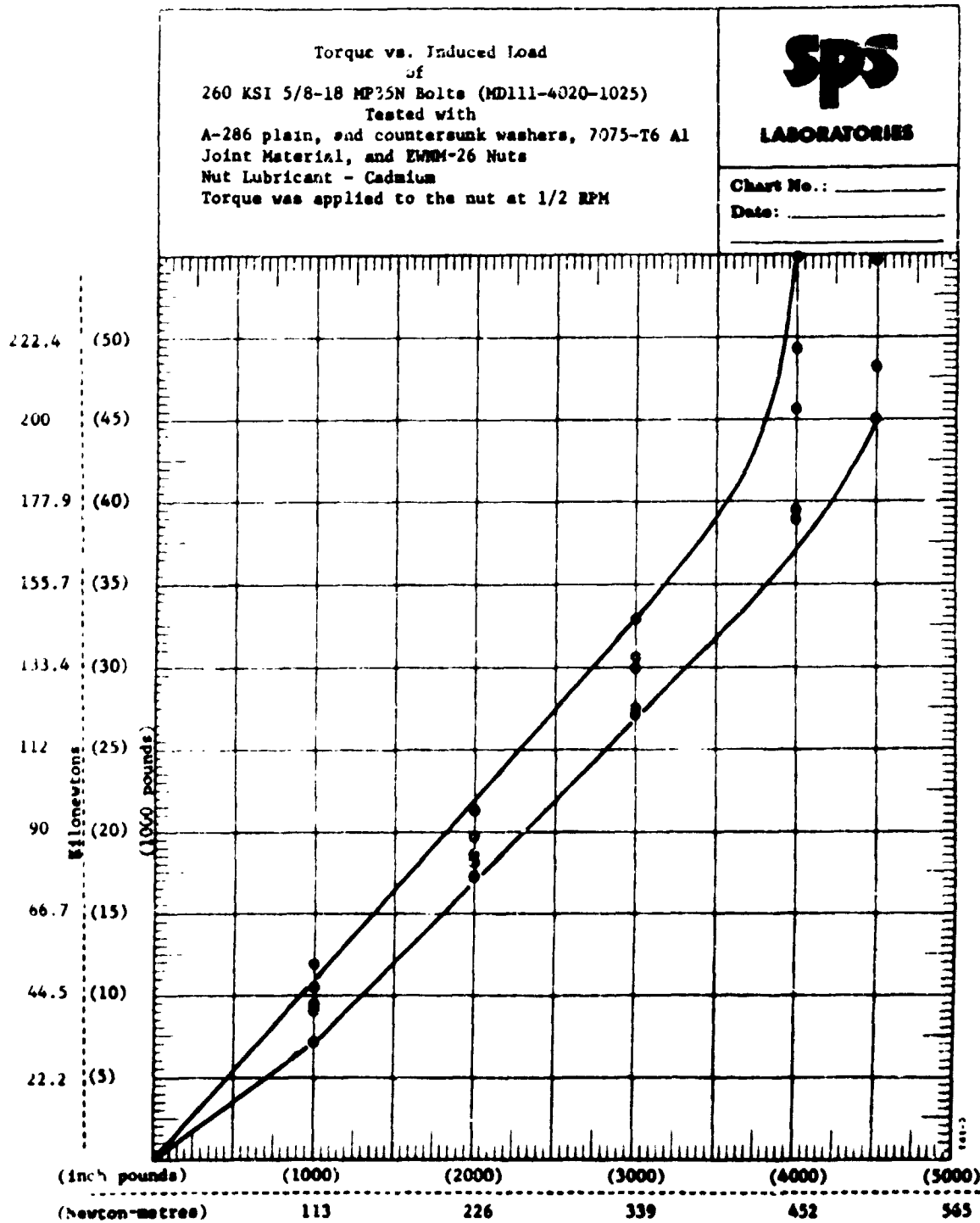


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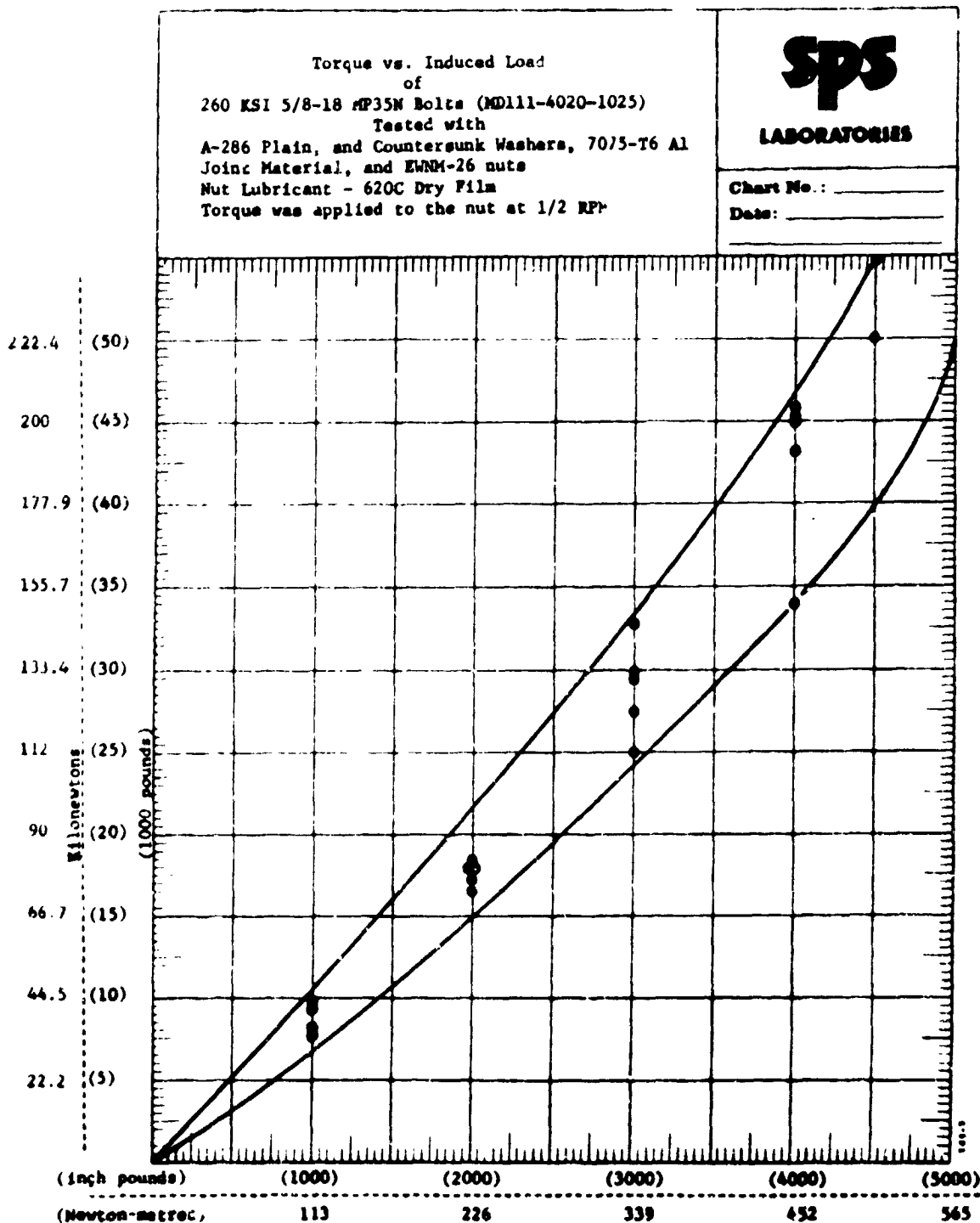


Figure 28.

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TABLE I

Ultimate Tensile Strength
of
EWB-0420 A286 Bolts
and Companion Nuts

Part	NAS1348 Area	Tensile Strength		Proportional Limit	
		pounds	psi	pounds	psi
EWB-0420-4-34	.0388	8200	211000	6800	175000
		8150	210000	6800	175000
		8320	214000	6900	178000
			211.7		176
EWB-0420-5-38	.0614	13000	212000	9500	155000
		13200	215000	10000	163000
		13000	212000	9500	155000
			213		157.7
EWB-0420-6-22	.0950	19200	202000	14500	153000
		19250	203000	14375	151000
		19150	202000	14250	150000
		19700	207000	14500	153000
EWB-0420-6-40	.1717		203.5		151.8
		36500	213000	28000	163000
		37000	215000	28000	163000
		36700	214000	26000	151000
EWB-0420-8-46	.2724	39000	227000	29000	169000
			217.2		161.5
		56500	207000	40000	147000
		56300	207000	40000	147000
EWB-0420-10-50	.2724	56500	207000	40000	147000
		58000	213000	42000	154000
			208.5		148.8

.831

.740

.746

.744

.714

OF POOR QUALITY

TABLE II

Ultimate Tensile Strength
of
MD111-4020-MP35N Bolts
and Companion Nuts

Part	NAS1348 Area	Tensile Strength		Proportional Limit	
		pounds	psi	pounds	psi
MD111-4020-0417	.0388	10180	262000	8800	227000
		10200	263000	8700	224000
		10240	264000	8900	229000
MD111-4020-0547	.0614	16250	265000	14250	232000
		16600	270000	13500	220000
		16800	274000	14000	228000
MD111-4020-0634	.095	24750	261000	19750	208000
		24875	262000	20250	213000
		25300	260000	20500	216000
MD111-4020-0822	.1717	46500	271000	37500	218000
		47000	274000	35500	207000
		47500	277000	37500	218000
MD111-4020-1025	.2724	72000	264000	62000	228000
		72000	264000	62000	228000
		72500	266000	62000	228000

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Maximum Allowable Bearing Stress
of
7075-T6 Aluminum Joint Material
Tested by Loading NAS 1587 Washers Against the Aluminum

<u>Size</u>	<u>Washer Bearing Area, square inches</u>	<u>Brinell Load, pounds</u>	<u>Joint Bearing Stress</u>	<u>Bolt Tensile Stress at Brinell Load</u>
1/4	.168	6000	36,000 psi	155,000 psi
5/16	.194	7000	36,000 psi	114,000 psi
3/8	.252	10500	42,000 psi	110,000 psi
1/2	.318	17000	53,000 psi	99,000 psi
			Avg. 41,750 psi	

TABLE IV

Maximum Allowable Bearing Stress
of
NAS 1587 Washers and A286 Nuts and Bolts
Tested by Loading A286 Bolts and Nuts Against the NAS1587 Washers

<u>Size</u>	<u>Nut and Head Bearing Area - Square inches</u>	<u>Brinell Load, pounds</u>	<u>Washer Bearing Stress-psi</u>	<u>Bolt Tensile Stress at Brinell Load</u>
1/4	.097	4000	41000	103000 psi
5/16	.139	6000	43000	98000 psi
3/8	.213	9000	42000	95000 psi
1/2	.330	17000	51000	99000 psi
			Avg. 44000	

OF POOR QUALITY

TABLE V

Maximum Allowable Bearing Stress
of
NAS 1587 Washers, and MP35N Nuts and Bolts
Tested by Loading MP35N Nuts and Bolts Against NAS 1587 Washers

<u>Size</u>	<u>Nut and Head Bearing Area - Square inches</u>	<u>Brinell Load, Pounds</u>	<u>Washer Bearing Stress</u>	<u>Bolt Tensile Stress at Brinell Load</u>
1/4	.124	5000	40000	128000 psi
5/16	.186	7500	40000	122000 psi
3/8	.294	12000	40000	126000 psi
1/2	.500	20000	40000	116000 psi

TABLE VI

Recommended Seating Torque
to Induce 90,000 psi Tensile
Stress* in the Bolt Threads
of EWB 0420 A286 Bolts and 61170 Nuts

1. EWB 0420 A286 Bolts, and 61170C (Cadmium Plated) A286 Nuts

<u>Bolt Size</u>	<u>Induced Load, pounds</u>	<u>Torque - in.-lbs.</u>	<u>Coeff. F.**</u>
1/4-28	3500	130	.15
5/16-24	5500	400	.23
3/8-24	8500	530	.17
1/2-20	15400	1650	.21
5/8-18	24500	2680	.18

2. EWB 0420 A286 Bolts, and 61170C (Cadmium Plated) A286 Nuts, and Cetyl Alcohol

1/4-28	3500	112	.13
5/16-24	5500	280	.16
3/8-24	8500	380	.12
1/2-20	15400	1200	.16
5/8-18	24500	1700	.11

3. EWB 0420 A286 Bolts, and 61170M (620C dry film) A286 Nuts

1/4-28	3500	135	.15
5/16-24	5500	280	.16
3/8-24	8500	480	.15
1/2-20	15400	1220	.16
5/8-18	24500	2300	.15

* Stress calculated using NAS 1348 Tensile Stress areas

** Coefficient of friction calculated using the formula $T = (\text{Nominal dia.}) (\text{Load}) (F)$.

TABLE VII

Recommended Torque to
Induce 90,000 PSI Tensile
Stress* in the Bolt Threads
of MD111-4020 MP35N Bolts,
and EWNM 26 Nuts

1. MD111-4020 MP35N Bolts, and EWNM 26 Cadmium Plated Nuts

<u>Bolt Size</u>	<u>Induced Load, pounds</u>	<u>Torque - in.-lbs.</u>	<u>Coeff F.**</u>
1/4-28	3500	160	.18
5/16-24	5500	500	.29
3/8-24	8500	800	.25
1/2-20	15400	1750	.23
5/8-18	24500	2500	.16

2. MD111-4020 MP35N Bolts, and EWNM 26 nuts with 620c dry film lubricant

1/4-28	3500	134	.15
5/16-24	5500	250	.15
3/8-24	8500	500	.16
1/2-20	15400	900	.12
5/8-18	24500	2600	.17

* Stress calculated using NAS 1348 Tensile stress areas

** Coefficient of friction calculated using the formula $T = (\text{Nominal dia.}) (Load) (F)$.

APPENDIX

Contains - :

1. Tables of Nut Seating Torques for the five combinations of fastener material and lubrication
2. Test Part Drawings

Nut Seating Torque
for
EWB 0420 A-286 Bolts and 61170C Cadmium Plated A-286 Nuts
with
NAS 1587 Plain and Countersunk Washers on 7075-T6 Joint Material

Bolt Size	Preload Stress					
	110,000 psi	90,000 psi	70,000 psi	50,000 psi	30,000 psi	10,000 psi
1/4-28	17.9 N/m (159) in-lb.	14.6 N/m (130) in-lb.	11.4 N/m (101) in-lb.	8.1 N/m (72) in-lb.	4.8 N/m (43) in-lb.	1.6 N/m (14) in-lb.
5/16-24	53.8 (477)	44.0 (400)	34.2 (303)	24.5 (217)	14.6 (130)	4.8 (43)
3/8-24	71.4 (632)	50.1 (530)	49.1 (435)	35.6 (315)	21.4 (190)	7.1 (63)
1/2-20	219.2 (1940)	186.4 (1650)	151.4 (1340)	116.4 (1030)	62.1 (550)	20.7 (183)
5/8-18	370.0 (3275)	302.7 (2680)	235.5 (2085)	168.3 (1490)	100.5 (890)	33.9 (300)

- Notes:
1. NAS8 - 32525 data base
 2. Torque in Newton-metres
 3. Torque in inch-pounds (XX)
 4. Preload stress based on NAS 1348 tensile stress areas
 5. For preload stress variation see SPS Laboratory Report No. 5920 (NAS8 - 32525)

Nut Seating Torque
for
EWB 0420 A-286 Bolts and 61170C Cadmium Plated A-286 Nuts with Cetyl Alcohol
with
NAS 1587 Plain and Countersunk Washers on 7075-T6 Joint Material

Bolt Size	Preload Stress					
	110,000 <u>psi</u>	90,000 <u>psi</u>	70,000 <u>psi</u>	50,000 <u>psi</u>	30,000 <u>psi</u>	10,000 <u>psi</u>
1/4-28	15.5 N/m (137)in-lb	12.6 N/m (112)in-lb	10.0 N/m (87)in-lb	7.0 N/m (62)in-lb	4.1 N/m (37)in-lb	1.4 N/m (12)in-lb
5/16-24	38.6 (342)	31.6 (280)	25.4 (225)	18.8 (166)	11.3 (100)	3.7 (32)
3/8-24	52.4 (464)	42.9 (380)	33.3 (295)	23.8 (211)	14.3 (127)	4.7 (42)
1/2-20	165.7 (1467)	135.5 (1200)	105.6 (935)	75.3 (667)	45.2 (400)	15.0 (133)
5/8-18	235.0 (2080)	192.0 (1700)	149.1 (1320)	106.7 (945)	64.0 (567)	21.5 (190)

- Notes:
1. NAS8 - 32525 data base
 2. Torque in Newton-metres
 3. Torque in inch-pounds (XX)
 4. Preload stress based on NAS 1348 tensile stress areas
 5. For preload stress variation see SPS Laboratory Report No. 5920 (NAS8 - 32525)

Nut Seating Torque
for
EWB-0420 A-286 Bolts and 61170C (620C Dry Film Coated) A-286 Nuts
with
NAS 1587 Plain and Countersunk Washers on 7075-T6 Joint Material

Bolt Size	Preload Stress					
	110,000 psi	90,000 psi	70,000 psi	50,000 psi	30,000 psi	10,000 psi
1/4-28	18.6 N/m (165)in-lb.	15.2 N/m (135)in-lb.	11.9 N/m (105)in-lb.	8.5 N/m (75)in-lb.	5.1 N/m (45)in-lb.	1.7 N/m (15)in-lb.
5/16-24	38.6 (342)	31.6 (280)	24.6 (218)	17.6 (156)	10.5 (93)	3.5 (31)
3/8-24	66.3 (587)	54.2 (480)	42.1 (373)	30.2 (267)	18.1 (160)	6.0 (53)
1/2-20	155.3 (1375)	137.8 (1220)	118.6 (1050)	89.2 (790)	53.5 (474)	17.8 (158)
5/8-18	317.6 (2811)	259.8 (2300)	202.1 (1789)	144.4 (1278)	86.6 (767)	28.9 (256)

- Notes:
1. NAS8 - 32525 data base
 2. Torque in Newton-metres
 3. Torque in inch-pounds (XX)
 4. Preload stress based on NAS 1348 Tensile stress areas
 5. For preload stress variation see SPS Laboratory Report No. 5920 (NAS8 - 32525)

Nut Seating Torque
for
MD111-4020 MP35N Bolts and EWNM-26 Cadmium Plated Nuts
with
NAS 1587 Plain and Countersunk washers on 7075-T6 Joint Material

Bolt Size	Preload Stress					
	110,000 psi	90,000 psi	70,000 psi	50,000 psi	30,000 psi	10,000 psi
1/4-28	22.1N/m (196) in-lb.	18.0N/m (160) in-lb.	14.0N/m (124) in-lb.	10.2N/m (90) in-lb.	6.0N/m (53) in-lb.	2.0 N/m (18) in-lb.
5/16-24	69.0 (611)	56.5 (500)	44.0 (390)	31.4 (278)	18.8 (167)	6.2 (55)
3/8-24	110.5 (978)	90.4 (800)	70.3 (622)	50.2 (444)	30.2 (267)	10.2 (90)
1/2-20	241.8 (2140)	197.7 (1750)	153.6 (1360)	109.8 (972)	65.9 (583)	21.9 (194)
5/8-18	345.1 (3055)	282.4 (2500)	219.6 (1944)	157.0 (1390)	94.1 (833)	31.4 (278)

- Notes:
1. NAS8 - 32525 data base
 2. Torque in Newton-metres
 3. Torque in inch-pounds (XX)
 4. Preload stress based on NAS 1348 Tensile stress areas
 5. For preload stress variation see SPS Laboratory Report No. 5920 (NAS8 - 32525)

Nut Seating Torque
for
MD111-4020 MP35N Bolts and EWNM-26 Nuts 620C Dry Film Coated
with
NAS 1587 Plain and Countersunk Washers on 7075-T6 Joint Material

Bolt Size	Preload Stress					
	110,000 psi	90,000 psi	70,000 psi	50,000 psi	30,000 psi	10,000 psi
1/4-28	18.5 N/m (164) in-lb	15.1 N/m (134) in-lb	11.7 N/m (104) in-lb	8.4 N/m (74) in-lb	5.1 N/m (45) in-lb	1.7 N/m (15) in-lb
5/16-24	34.5 (305)	28.2 (250)	21.9 (194)	15.7 (139)	9.4 (83)	3.2 (28)
3/8-24	64.9 (575)	56.5 (500)	43.9 (389)	31.4 (278)	18.9 (167)	6.3 (56)
1/2-20	118.6 (1050)	101.7 (900)	79.0 (700)	56.5 (500)	33.9 (300)	11.3 (100)
5/8-18	344.6 (3050)	293.7 (2600)	242.9 (2150)	173.4 (1535)	103.9 (920)	34.7 (307)

- Notes:
1. NAS8 - 32525 data base
 2. Torque in Newton-metres
 3. Torque in inch-pounds (XX)
 4. Preload stress based on NAS 1348 Tensile stress areas
 5. For preload stress variations see SPS Laboratory Report No. 5920 (NAS8 - 32525)

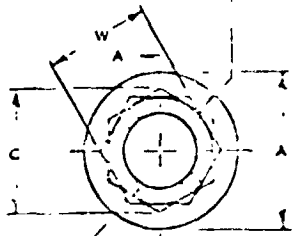
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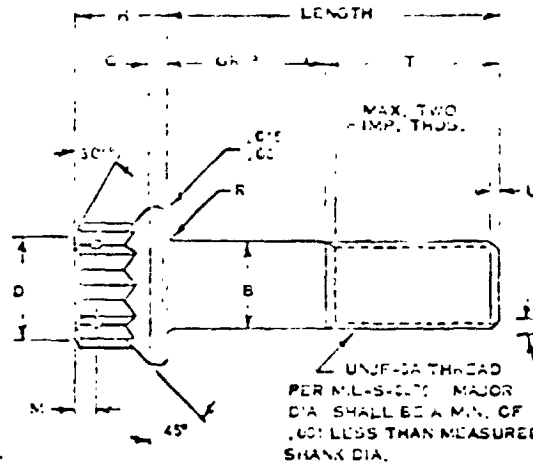
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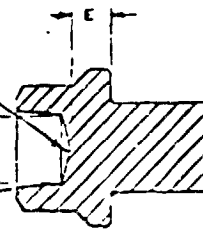
DRILL 1/4" DIAMETER, FOUR
HOLES, WHEN REQUIRED
BRAIN SHARP OUTSIDE
EDGES.



STAMP SPS-B-58952 AND
APPLICABLE DIAMETER
DASH NUMBER, 0420 MAX.
DEEP



FLAT, CURVED, OR
ANGULAR BOTTOM
OPTIONAL



SECTION A-A

UNF-3A THREAD
PER MIL-S-8837 MAJOR
DIA. SHALL BE A MIN. OF
.001 LESS THAN MEASURED
SHANK DIA.

PART NO.	HEAD UNF-3A	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	T	U	V	X	Y
EWB 0420-3	1/4-32	.345	.14	.265	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-4	3/8-24	.413	.14	.303	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-5	1/2-20	.506	.14	.401	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-6	3/4-16	.624	.14	.502	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-7	1-12	.745	.14	.619	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-8	1 1/8-10	.873	.14	.740	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-9	1 1/4-8	.993	.14	.850	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-10	1 1/2-7	1.125	.14	.972	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-11	1 3/8-6	1.225	.14	1.072	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13
EWB 0420-12	1 1/2-6	1.325	.14	1.172	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13

NOTES:

- MATERIAL: A-286 PER AMS 5737.
- PLAT TREATMENT: 200,000 PSI MINIMUM ULTIMATE TENSILE STRENGTH.
- FINISH: CADMIUM PLATE PER QQ-P-416, TYPE I, CLASS 3, OR TYPE II, CLASS 3, OR PLAIN, WHEN SPECIFIED.
- CONCENTRICITY: DIMENSIONS "A" AND "B" WITHIN .001 T.I.R.
BODY AND PITCH DIAMETER WITHIN .001 T.I.R.
- PART NUMBER: FIRST DASH NUMBER DESIGNATES DIAMETER IN SIXTEENTHS.
SECOND DASH NUMBER DESIGNATES GRIP IN SIXTEENTHS.
ADD "H" TO FIRST DASH NUMBER TO DESIGNATE CROSSRILLED HEAD.
ADD "C" TO SECOND DASH NUMBER FOR CADMIUM PLATE PER QQ-P-416, TYPE I, CLASS 3.
ADD "D" TO BASIC PART NUMBER FOR CADMIUM PLATE PER QQ-P-416, TYPE II, CLASS 3.
EXAMPLES: EWB 0420-4-20 = .250-20 EXTERNAL WRENCHING BOLT, .817 LONG, .500 GRIP, WITH CADMIUM PLATE PER QQ-P-416, TYPE I, CLASS 3.
EWB 0420-6H-10 = .375-24 EXTERNAL WRENCHING BOLT 1.262 LONG, .625 GRIP CROSSRILLED HEAD.
EWB 0420D-6-10 = .375-24 EXTERNAL WRENCHING BOLT 1.262 LONG, .625 GRIP, WITH CADMIUM PLATE PER QQ-P-416, TYPE II, CLASS 3.
- REFERENCE DIMENSIONS FOR DESIGN PURPOSES AND ARE NOT AN INSPECTION REQUIREMENT.
- DIMENSIONS IN INCHES.
- CHAMFER "U" BY 45° APPROX. CHAMFER PLUS INCOMPLETE THREADS NOT TO EXCEED TWO PITCHES.
- FOR WEIGHTS SEE SPS 50,300,58952.

STANDARD

FANCES .613 AND .427 UNLESS OTHERWISE NOTED

K INDICATES LATEST CHANGE

STANDARDS AND SPECIFICATIONS

TITLE

DRAWN BY J. LED. DATE 8-31-62

APPROVED *[Signature]* DATE 10-31-62

PART NUMBER

EWB 0420

SPS-B-543
APPENDIX 4,5

F.D. IDENT. CODE NO. 5678

BOLT, TENSION, EXTERNAL WRENCHING
200,000 PSI MINIMUM TENSILE STRENGTH
FOR CRYOGENIC APPLICATIONS
A-286 MATERIAL PER AMS 5737

JEWINGTON, PENNA.

SPS-B-58952

DIVISION

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DRAWN

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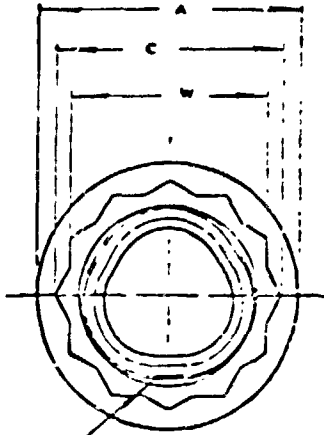
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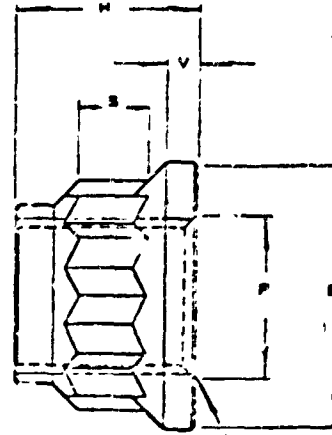
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DASH NO.	GRIP S. C. 10	LENGTH - 6 FT. DIAMETER (AS IN)									
		-3 .512	-4 .625	-5 .750	-6 .875	-7 1.000	-8 1.125	-9 1.250	-10 1.375	-11 1.500	-12 1.625
2	.100	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
4	.200	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
6	.300	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
8	.400	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
10	.500	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
12	.600	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
14	.700	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
16	.800	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
18	.900	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
20	1.000	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
22	1.100	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
24	1.200	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
26	1.300	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
28	1.400	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
30	1.500	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
32	1.600	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
34	1.700	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
36	1.800	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
38	1.900	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
40	2.000	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
42	2.100	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
44	2.200	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
46	2.300	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
48	2.400	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
50	2.500	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
52	2.600	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
54	2.700	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
56	2.800	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
58	2.900	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
60	3.000	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
62	3.100	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
64	3.200	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
66	3.300	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
68	3.400	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
70	3.500	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
72	3.600	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
74	3.700	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
76	3.800	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
78	3.900	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
80	4.000	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
82	4.100	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
84	4.200	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
86	4.300	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
88	4.400	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
90	4.500	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
92	4.600	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
94	4.700	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
96	4.800	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
98	4.900	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
100	5.000	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
102	5.100	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
104	5.200	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
106	5.300	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
108	5.400	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
110	5.500	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625
112	5.600	.512	.625	.750	.875	1.000	1.125	1.250	1.375	1.500	1.625

INTERMEDIATE AND LONGER LENGTHS MAY BE SPECIFIED BY THE USE OF WHOLE GRIP DASH NUMBERS ONLY.



BEARING SURFACE IS
OF POOR QUALITY



TOOL MARKS AND DISTORTION AT TOP OF NUT
DUE TO LOCKING FEATURE PERMISSIBLE.

COUNTERSINK,
COUNTERBONE, OR RADIUS RELIEF
TO THREAD WITHIN THE LIMITS
OF "P" DIA.

DASH NO.	(1) THREAD	A DIA MAX	B DIA MIN	C MIN	H MAX	P DIA MAX	S MIN	V MIN	W MAX	X MIN	TENSILE STRENGTH LBS. MIN.	APPROX. WEIGHT LBS/100
-1414	.875-14 UNF-3H	1.418	1.393	1.200	1.0-0	.910	.350	.145	1.064	1.052	102,000	16.97
-1412	1.000-12 UNF-3H	1.675	1.580	1.344	1.210	1.015	.400	.170	1.910	1.178	133,640	24.72
-1411	1.125-12 UNF-3H	1.875	1.805	1.552	1.370	1.140	.410	.170	1.377	1.361	171,000	36.24
-1410	1.250-12 UNF-3H	2.125	2.075	1.800	1.510	1.285	.400	.210	1.507	1.489	215,000	56.90
-2412	1.375-12 UNF-3H	2.375	2.275	1.875	1.570	1.410	.550	.250	1.627	1.614	265,000	63.43
-2410	1.500-12 UNF-3H	2.500	2.450	1.950	1.610	1.515	.600	.290	1.752	1.739	316,000	79.63

(1) THIS ADS: BEFORE LUBRICATION PER MIL-S-8872.

NOTES:

- MATERIAL: A-286 CRE5 PER SPS-M-110.
- HARDNESS: ROCKWELL C42 MAXIMUM.
- PLATING: SILVER PLATE PER AMS 2410 (.0003-.0005 THICK).
- LUBRICANT: NON-DRY LUBRICANT UNLESS OTHERWISE SPECIFIED PARTS SHALL BE SUPPLIED WITH A NON DRY LUBRICANT SOLUBLE IN THE CLEANER SPECIFIED IN MIL-S-7502.
- FLUORESCENT PENETRANT INSPECT PER AMS 2645 EXCEPT OMIT IDENTIFICATION.
- LOCKING TORQUE PER MIL-N-25027.
- BEARING SQUARENESS: BEARING SURFACE TO BE SQUARE WITH PITCH DIAMETER WITHIN ".X" T.I.R. WHEN CHECKED AT A POINT MIDWAY BETWEEN THE O.D. AND I.O. OF THE BEARING SURFACE.
- SURFACE TEXTURE: ASA 84.1, UNLESS OTHERWISE SPECIFIED THE SURFACE TEXTURE SHALL NOT EXCEED 125 MICROINCHES.
- DIMENSIONS TO BE MET PRIOR TO LUBRICATION. DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED.
- PART NUMBER: PART NUMBER CONSISTS OF BASIC PART NUMBER "61170" PLUS DASH NUMBER.
EXAMPLE: 61170-1414 .875-14 UNF-3H NUT, A-286 MATERIAL SILVER PLATED.

11-9-72
ROBERT G. DAVENPORT

TOLERANCES: AND UNLESS OTHERWISE NOTED

STANDARDS AND SPECIFICATIONS

TITLE

MIL-N-25027

NUTS
SELF-LOCKING, EXTERNAL WRENCHING,
200 KSI, A 286,

FOR LOCKING APPLICATIONS

DRAWN BY P.J.K. DATE 6-25-67

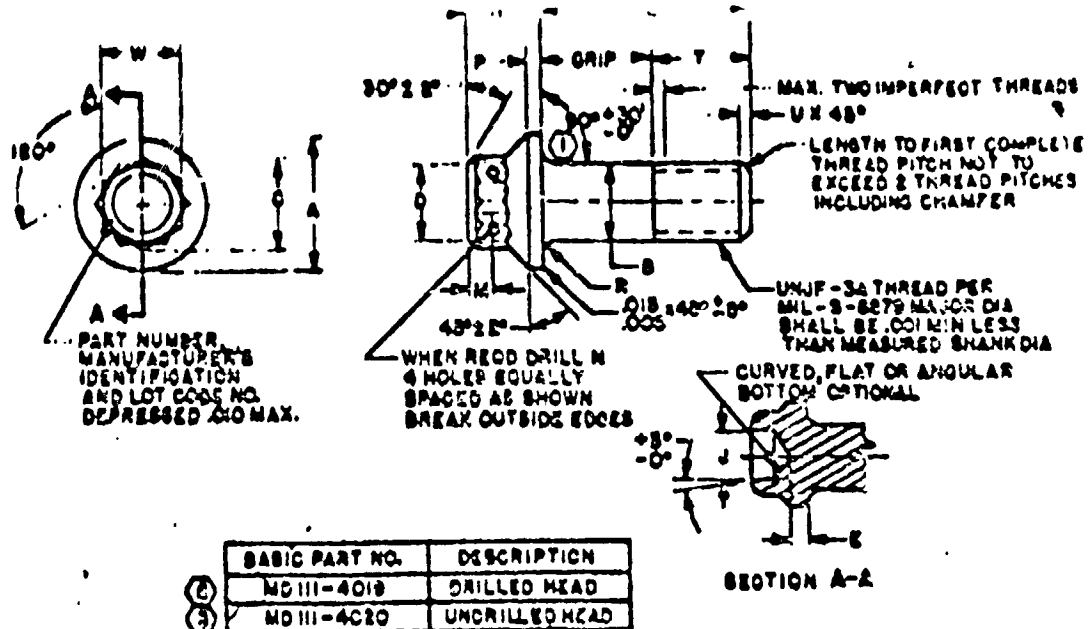
APPROVED DATE 6-25-67

PART NUMBER

61170

ESTD. 1947, PITTSBURGH, PA.

CLASSIFICATION
OF FOUR QUALITY



MATERIAL: HIGH STRENGTH CORROSION RESISTANT ALLOY, MP35N, PER AMS5738.

HEAT TREATMENT: 240,000 TO 275,000 PSI ULTIMATE TENSILE STRENGTH AND 132,000 PSI MINIMUM ULTIMATE SHEAR STRENGTH.

FINISH: PASSIVATE PER MIL-B-9002.

PERFORMANCE SPECIFICATION: MC111 0317

CODE: FIRST TWO DIGITS OF DASH NO. INDICATE NOMINAL DIAMETER AND THREAD SIZE (TABLE I).
SECOND TWO DIGITS OF DASH NO. INDICATE GRIP AND LENGTH (TABLE II).

EXAMPLE OF PART NUMBER: MD111-4019-0404

EXTERNAL WRENCHING BOLT

- ① 19 - DRILLED HEAD
- ① 20 - UNDRILLED HEAD

GRIP .250 AND LENGTH .750
NOMINAL DIAMETER .2500 AND
.2500-28 UNJF-3A THREAD

NOTES:

1. CONCENTRICITY: "A" AND "B" DIAMETERS WITHIN "X" TIR. WRENCHING SURFACE AND BODY WITHIN .010 TIR. "B" DIA AND THREAD P.D. WITHIN "Y" TIR.
- ① 2. BEARING SURFACE: 90° ± 5° TO SHANK AT A POINT ON THE SHANK ONE BOLT DIAMETER FROM BEARING SURFACE OF HEAD.
3. SHANK STRAIGHTNESS: WITHIN .0005 INCH PER INCH OF BOLT LENGTH.
4. SURFACE ROUGHNESS: "B" DIAMETER, HEAD BEARING SURFACE, AND THREAD FLANKS AND ROOT 32 MICRINCHES, OTHER SURFACES 125 MICRINCHES PER ANSI B46.1.
5. BREAK SHARP EDGES .010 ± .005 X 45° UNLESS OTHERWISE SPECIFIED.
6. 100% FLUORESCENT PENETRANT INSPECT PER MIL-I-6866.
7. GRIP LENGTH: FROM UNDERSIDE OF HEAD TO END OF CYLINDRICAL PORTION OF SHANK. GRIP IN .005 INCH INCREMENTS.
8. REFERENCE DIMENSIONS ARE FOR DESIGN PURPOSES ONLY AND ARE NOT AN INSPECTION REQUIREMENT.

TOLERANCES, EXCEPT AS NOTED		TOLERANCES ON .015 THRU .040 + .001 - .001		.601 THRU .750 + .005 - .001		CODE IF INT NO
ANGLES ± 30° DECIMALS .25 = ± .005		.041 THRU .130 + .002 - .001		.751 THRU 1.025 + .007 - .001		03953
.50 = ± .010		.131 THRU .250 + .003 - .001		1.001 THRU 2.000 + .010 - .001		
DR BY W. HANLEY		DATE 4-4-78		SPACE DIVISION		STANDARD PART
CHK BY J.P.		1-2-77		NORTH AMERICAN KICKWITZ CORPORATION		
APPD J.P.		1-2-77		12401 E. 1st Avenue, Suite 100, Denver, CO 80231		
BOLT - TENSION, 12 POINT EXTERNAL WRENCHING, 240KSI MIN TENSILE, 750CF				MD III-4019 AND MD III-4020		

RECEIVED

MAR 8 1975

S. P. S. WESTERN
ENGR. DEPT.

76663

REVISED 4-8-74

TABLE (CONTINUED)

DESIGN AND USAGE INFORMATION

- NY-61-6 (Y) 0351A30

TOLERANCES, EXCEPT AS NOTED		TOLERANCES ON HOLES NOTED "HOLE"		.01 THRU .040 + .001 - .001 .041 THRU .130 + .002 - .001 .131 THRU .229 + .003 - .001 .230 THRU .500 + .004 - .001		.501 THRU .750 + .005 - .001 .751 THRU 1.000 + .007 - .001 1.001 THRU 2.000 + .010 - .001		COPE IDENT NO 03953	
ANGLES 30° DECIMALS XX = .03 XXX = .010				SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION 12101 NORTH 52nd Street, Omaha, NE 68148		STANDARD PART MD11-4019 AND MD11-4020			
DR BY	W. HARLEY	4-4-74							
CHK BY									
APPD			BOLT - TENSION, 12 POINT EXTERNAL						
APPD			WRENCHING, 240KSI MIN TENSILE, 750F						

OF POOR QUALITY

LENGTHS IN INCHES										
NOMINAL DIAMETER DASH IN INCHES										
		1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8
XX10	1.625	1.015	1.123	1.207	1.297	1.410	1.500	1.607	1.722	1.890
XX12	1.750	1.140	1.210	1.332	1.422	1.535	1.625	1.732	1.847	2.015
XX14	1.875	1.265	1.373	1.457	1.547	1.660	1.750	1.857	1.972	2.140
XX16	2.000	1.390	1.498	1.532	1.672	1.795	1.875	1.932	2.097	2.265
XX18	2.125	1.515	1.623	1.707	1.797	1.910	2.000	2.107	2.222	2.390
XX20	2.250	1.640	1.746	1.832	1.922	2.035	2.125	2.232	2.347	2.515
XX22	2.375	1.765	1.873	1.957	2.047	2.160	2.250	2.357	2.472	2.640
XX24	2.500	1.890	1.998	2.082	2.172	2.285	2.375	2.482	2.597	2.765
XX26	2.625		2.123	2.207	2.297	2.410	2.500	2.607	2.722	2.890
XX28	2.750		2.249	2.332	2.422	2.535	2.625	2.732	2.847	3.015
XX30	2.875		2.373	2.457	2.547	2.660	2.750	2.857	2.972	3.140
XX32	3.000		2.498	2.582	2.672	2.785	2.875	2.982	3.097	3.265
XX34	3.125		2.623	2.707	2.797	2.910	3.000	3.107	3.222	3.390
XX36	3.250			2.832	2.922	3.035	3.125	3.232	3.347	3.515
XX38	3.375			2.957	3.047	3.160	3.250	3.357	3.472	3.640
XX40	3.500			3.082	3.172	3.285	3.375	3.482	3.597	3.765
XX42	3.625				3.297	3.410	3.500	3.607	3.722	3.890
XX44	3.750				3.422	3.535	3.625	3.732	3.847	4.015
XX46	3.875				3.547	3.660	3.750	3.857	3.972	4.140
XX48	4.000				3.672	3.785	3.875	3.982	4.097	4.265
XX50	4.125					3.910	4.000	4.107	4.222	4.390
XX52	4.250					4.035	4.125	4.232	4.347	4.515
XX54	4.375					4.160	4.250	4.357	4.472	4.640
XX56	4.500					4.285	4.375	4.482	4.597	4.765
XX58	4.625						4.500	4.607	4.722	4.890
XX60	4.750						4.625	4.732	4.847	5.015
XX62	4.875						4.750	4.857	4.972	5.140
XX64	5.000						4.875	4.982	5.097	5.265
XX66	5.125						5.000	5.107	5.222	5.390
XX68	5.250						5.125	5.232	5.347	5.515
XX70	5.375						5.250	5.357	5.472	5.640
XX72	5.500						5.375	5.482	5.597	5.765
XX74	5.625						5.500	5.607	5.722	5.890
XX76	5.750						5.625	5.732	5.847	6.015
XX78	5.875						5.750	5.857	5.972	6.140
XX80	6.000						5.875	5.982	6.097	6.265
XX82	6.125						6.000	6.107	6.222	6.390
XX84	6.250						6.125	6.232	6.347	6.515
XX86	6.375						6.250	6.357	6.472	6.640
XX88	6.500						6.375	6.482	6.597	6.765
XX90	6.625						6.500	6.607	6.722	6.890
XX92	6.750						6.625	6.732	6.847	7.015
XX94	6.875						6.750	6.857	6.972	7.140
XX96	7.000						6.875	6.982	7.097	7.265

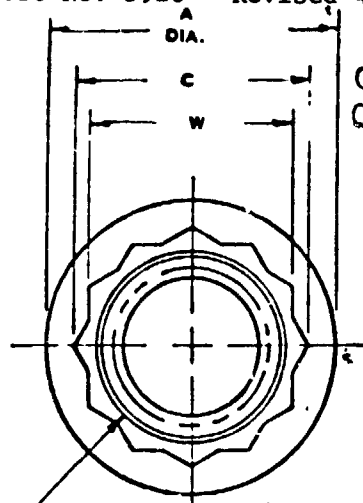
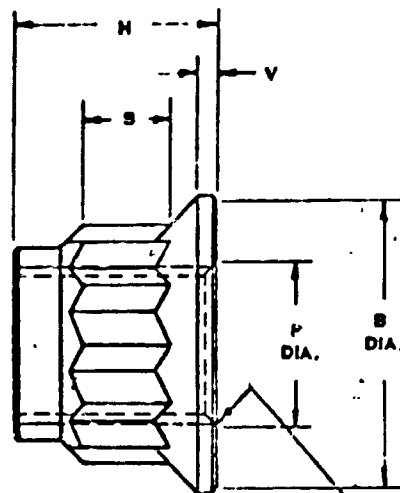
INTERMEDIATE GRIP LENGTHS IN .0025 INCREMENTS OR LONGER GRIP LENGTHS IN .0025 INCREMENTS MAY BE OBTAINED BY SPECIFYING SIGNIFICANT DASH NUMBERS. FOR GRIP LENGTHS LONGER THAN 2.11 INCHES SEE #0111-4013 AND #0111-4015.
NOMINAL GRIP LENGTH PLUS "T REF" (TOTALS 20.11 INCHES $\pm .015$).

NOMINAL GRIP LENGTH PLUS "T RCF" (TOTALS BOLT LENGTH $\pm .015$)

TOLERANCES, EXCEPT AS NOTED			TOLERANCES ON HOLES: NOTED "HILL"			.013 THRU .040 + .001 - .001 .041 THRU .130 + .002 - .001 .131 THRU .220 + .003 - .001 .221 THRU .500 + .004 - .001			.501 THRU .750 + .005 - .001 .751 THRU 1.000 + .007 - .001 1.001 THRU 2.000 + .010 - .001			DUNE 1.1111111111111111 03953					
ANGLES = 30' DECIMALS XX = ± .03 XXX = ± .010																	
DR BY		W. HARLEY		4-4-74		SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION 17714 LANTANA BLVD. - LANTANA, CALIFORNIA 92031 52						STANDARD PART					
CHK BY												MDIII-1019 AND MDIII-4020					
APPD						BOLT - TENSION, 12 POINT EXTERNAL WRINGING, 240KSI MIN TLM HILL, 750F											
APPD												SHEET 1 53					



Report No. 5920 - Revised 4/27/78

ORIGINAL DRAWING IS
OF POOR QUALITY.

DASH NO	THREAD SIZE (1)	A MAX	B MIN	C MIN	H MAX	P MAX	S MIN	V MIN	W		X (2)	Y (3)	AXIAL STRENGTH LBS. MIN	WEIGHT MAXIMUM LBS/100
									MAX	MIN				
-1032	170-32 UNJF-3B	369	329	277	265	220	088	008	251	243	002	002	5,850	31
-428	250-28 UNJF-3B	475	435	347	355	260	121	015	313	305	002	002	10,500	3
-524	312-24 UNJF-3B	585	545	419	415	342	153	019	376	367	002	002	16,500	1.17
-622	375-24 UNJF-3B	725	685	561	505	405	200	031	502	492	002	002	24,700	2.25
-720	437-20 UNJF-3B	830	780	631	535	473	234	037	564	553	001	001	33,500	3.75
-818	500-20 UNJF-3B	910	860	703	675	535	264	040	637	616	001	001	41,500	4.60
-916	572-18 UNJF-3B	1,035	985	846	760	592	333	017	752	741	004	001	56,000	7.21
-1018	625-18 UNJF-3B	1,195	1,145	917	875	660	357	047	814	803	004	003	70,800	9.53
-1216	750-16 UNJF-3B	1,425	1,375	1,059	1,015	785	417	010	940	929	003	003	103,000	15.16
-1414	875-14 UNJF-3B	1,645	1,595	1,271	1,185	910	519	014	1,127	1,116	005	003	140,000	23.02
-1612	1,000-12 UNJF-3B	1,870	1,830	1,414	1,395	1,035	616	027	1,257	1,239	006	004	182,000	31.42
-1812	1,125-12 UNJF-3B	2,100	2,050	1,628	1,570	1,110	748	015	1,410	1,407	007	005	214,000	45.53
-2012	1,250-12 UNJF-3B	2,355	2,305	1,842	1,750	1,285	882	028	1,627	1,614	007	005	292,000	67.27

(1) THREADS - BEFORE LUBRICATION PER MIL-S-8879

(2) BEARING SQUARENESS - BEARING SURFACE TO BE SQUARE WITH PITCH DIAMETER WITHIN X T.I.R. WHEN CHECKED AT A POINT MIDWAY BETWEEN THE O.D. AND I.D. OF THE BEARING SURFACE.

(3) BEARING FLATNESS - BEARING SURFACE TO BE FLAT TO CONCAVE WITHIN Y T.I.R. WHEN CHECKED IN ACCORDANCE WITH SPS-G-1013

MATERIAL - MP 35N PER AMS 5758

PLATING - SILVER PLATE PER AMS2410, THICKNESS .0002-.0006 OR CADMIUM PLATE PER QQ-P-418, TYPE II CLASS 2. (5)

LUBRICANT - MOLYBDENUM DISULFIDE DRY FILM LUBRICANT ON SILVER PLATE ONLY (5)

FLUORESCENT PENETRANT INSPECT PER SPS-I-700, LEVEL II

LOCKING TORQUE PER SPECIFICATION SPS-E-613

BREAK SHARP CORNERS

DIMENSIONS IN INCHES UNLESS SPECIFIED OTHERWISE. DIMENSIONS TO BE MET PRIOR TO LUBRICATION

PERFORMANCE - SEE PROCUREMENT SPECIFICATION

DESIGN AND USAGE LIMITATIONS - THESE NUTS ARE DESIGNED TO DEVELOP THE TENSILE STRENGTH OF BOLTS AND SCREWS WITH AN ULTIMATE TENSILE STRENGTH OF 260 KSI BASED ON A CROSS SECTIONAL AREA AT THE BASIC PITCH DIAMETER. THESE NUTS ARE DESIGNED TO BE USED WITH COMPANION BOLT PRODUCED TO DWG. SPS-B-70313

PART NUMBER -

EWN26 C - 428 = 250-28 NUT, CADMIUM PLATED (5)

DASH NUMBER FROM TABULATION DESIGNATING NOM, THREAD SIZE AND PITCH.

"C" DESIGNATES TYPE II CADMIUM PLATING, NO LETTER DESIGNATES SILVER PLATING WITH DRY FILM LUBRICANT. (5)

BASIC PART NUMBER.

THIS STANDARD TAKES PRECEDENCE OVER DOCUMENTS REFERENCED HEREIN. REFERENCED DOCUMENTS SHALL BE OF THE ISSUE IN EFFECT ON DATE OF INVITATION FOR BID. PART NUMBERS OTHER THAN LISTED ON THIS DRAWING SHALL NOT BE USED.

* INDICATES LATEST CHANGE

TOLERANCES: .010 AND .02 UNLESS OTHERWISE NOTED

STANDARD

STANDARDS AND SPECIFICATIONS

TITLE

DRAWN BY T.M.G. DATE 2-28-78

APPROVED J. L. DATE 5-2-78

PART NUMBER

SPS-E-613

NUT, FLEXLOC, DOUBLE HEXAGON, SELF-LOCKING

MP 35 N, 700°F, 260 KSI

FED. IDENT. CODE NO. 36078

FOR USE WITH MIL-S-8879 EXTERNAL THREADS (1)

EWN26

26

SPS-N-70538

REVISION 1 2-18-69

2 11-6-69

3 1-27-74

4 4-15-74

5 4-27-78